

TEMPLATE-FIXED PEPTIDOMIMETICS AS MEDICAMENTS AGAINST HIV AND CANCER

The present invention provides template-fixed β -hairpin peptidomimetics incorporating two
5 template-fixed chains of 4 and 6 or 5 and 7 α -amino acid residues which, depending on their
positions in the chains, are Gly or Pro, or of certain types, as defined herein below. These
template-fixed β -hairpin mimetics have antagonizing CXCR4-activity. In addition, the present
invention provides an efficient synthetic process by which these compounds can, if desired, be
made in parallel library-format. These β -hairpin peptidomimetics show improved efficacy,
10 bioavailability, half-life and most importantly a significantly enhanced ratio between
antagonizing CXCR4 activity on the one hand, and hemolysis on red blood cells and
cytotoxicity on the other.

To date the available therapies for the treatment of HIV infections have been leading to a
15 remarkable improvement in symptoms and recovery from disease in infected people. Although
the highly active anti retroviral therapy (HAART-therapy) which involves a combination of
reverse transcriptase/protease inhibitor has dramatically improved the clinical treatment of
individuals with AIDS or HIV infection, there have still remained several serious problems
including multi drug resistance, significant adverse effects and high costs. Particularly desired
20 are anti HIV agents that block the HIV infection at an early stage of the infection, such as the
viral entry.

It has recently been recognized that for efficient entry into target cell, human
immunodeficiency viruses require the chemokine receptors CCR5 and CXCR4 as well as the
25 primary receptor CD4 (N. Levy, *Engl. J. Med.*, **335**, 29, 1528-1530). Accordingly, an agent
which could block the CXCR4 chemokine receptors should prevent infections in healthy
individuals and slow or halt viral progression in infected patients (*Science*, **1997**, 275, 1261-
1264).

30 Among the different types of CXCR4 inhibitors (M. Schwarz, T. N. C. Wells, A.E.I. Proudfoot,
Receptors and Channels, **2001**, 7, 417-428), one emerging class is based on naturally occurring
cationic peptide analogues derived from Polyphemus II which have an antiparallel β -sheet
structure, and a β -hairpin that is maintained by two disulfide bridges (H. Nakashima, M.

Masuda, T. Murakami, Y. Koyanagi, A. Matsumoto, N. Fujii, N. Yamamoto, *Antimicrobial Agents and Chemoth.* **1992**, *36*, 1249-1255; H. Tamamura, M. Kuroda, M. Masuda, A. Otaka, S. Funakoshi, H. Nakashima, N. Yamamoto, M. Waki, A. Matsumoto, J.M. Lancelin, D. Kohda, S. Tate, F. Inagaki, N. Fujii, *Biochim. Biophys. Acta* **1993**, *209*, 1163; WO 95/10534 A1).

Synthesis of structural analogs and structural studies by nuclear magnetic resonance (NMR) spectroscopy have shown that the cationic peptides adopt well defined β -hairpins conformations, due to the constraining effect of the single or two disulfide bridges (H. Tamamura, M. Sugioka, Y. Odagaki, A. Omagari, Y. Kahn, S. Oishi, H. Nakashima, N. Yamamoto, S.C. Peiper, N. Hamanaka, A. Otaka, N. Fujii, *Bioorg. Med. Chem. Lett.* **2001**, 359-362). These results show that the β -hairpin structure plays an important role in antagonizing CXCR4-activity.

Additional structural studies have also indicated that the antagonizing activity can also be influenced by modulating amphiphilic structure and the pharmacophore (H. Tamamura, A. Omagari, K. Hiramatsu, K. Gotoh, T. Kanamoto, Y. Xu, E. Kodama, M. Matsuoka, T. Hattori, N. Yamamoto, H. Nakashima, A. Otaka, N. Fujii, *Bioorg. Med. Chem. Lett.* **2001**, *11*, 1897-1902; H. Tamamura, A. Omagari, K. Hiramatsu, S. Oishi, H. Habashita, T. Kanamoto, K. Gotoh, N. Yamamoto, H. Nakashima, A. Otaka, N. Fujii, *Bioorg. Med. Chem.* **2002**, *10*, 1417-1426; H. Tamamura, K. Hiramatsu, K. Miyamoto, A. Omagari, S. Oishi, H. Nakashima, N. Yamamoto, Y. Kuroda, T. Nakagawa, A. Otaki, N. Fujii, *Bioorg. Med. Chem. Letters* **2002**, *12*, 923-928).

A key issue in the design of CXCR4 antagonizing peptides is selectivity. The Polyphemusin II derived analogs exert still a cytotoxicity despite improvements (K. Matsuzaki, M. Fukui, N. Fujii, K. Miyajima, *Biochim. Biophys. Acta* **1991**, *259*, 1070; A. Otaka, H. Tamamura, Y. Terakawa, M. Masuda, T. Koide, T. Murakami, H. Nakashima, K. Matsuzaki, K. Miyajima, T. Ibuka, M. Waki, A. Matsumoto, N. Yamamoto, N. Fujii *Biol. Pharm. Bull.* **1994**, *17*, 1669 and references cited above.

This cytotoxic activity essentially obviates use in vivo, and represents a serious disadvantage in clinical applications. Before intravenous use can be considered, the general toxicity, protein-binding activity in blood serum, as well as protease stability become serious issues which must be adequately addressed.

In addition it has recently been discovered, that the CXCR4-receptor is involved in chemotactic activity of cancer cells, such as breast cancer metastasis or ovarian cancer (A. Muller, B. Homey, H. Soto, N. Ge, D. Catron, M.E. Buchanan, T. Mc Clanahan, E. Murphey, W. Yuan, S.N. Wagner, J. Luis Barrera, A. Mohar, E. Verastegui, A. Zlotnik, *Nature* **2001**, *50*, 410, J. M. Hall, K. S. Korach, *Molecular Endocrinology*, **2003**, 1-47;), Non-Hodgkin's Lymphoma (F. Bertolini, C. Dell'Agnola, P. Manusco, C. Rabascio, A. Burlini, S. Monestiroli, A. Gobbi, G. Pruneri, G. Martinelli, *Cancer Research* **2002**, *62*, 3106-3112), or lung cancer (T. Kijima, G. Maulik, P. C. Ma, E. V. Tibaldi, R.E. Turner, B. Rollins, M. Sattler, B.E. Johnson, R. Salgia, *Cancer Research* **2002**, *62*, 6304-6311) or in inflammatory diseases e.g. such as rheumatoid arthritis, asthma, or multiple sclerosis (K.R. Shadidi et al, *Scandinavian Journal of Immunology*, **2003**, *57*, 192-198, J. A. Gonzalo *J. Immunol.* **2000**, *165*, 499-508, S. Hatse et al, *FEBS Letters* **2002** *527*, 255-262 and cited references). Blocking the chemotactic activity with a CXCR4 inhibitor should stop the migration of cancer cells. The mediation of recruitment of immunecells to sites of inflammation should be stopped by a CXCR4 inhibitor. Particularly desired are agents for treatment of cancer or agents for treatment of inflammatory disorders.

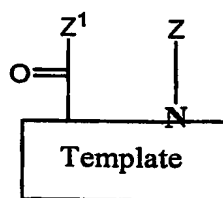
In the compounds described below, a new strategy is introduced to stabilize beta-hairpin conformations in bridged-backbone peptide mimetic exhibiting high CXCR4 antagonizing activity and anticancer activity and anti inflammatory activity. This involves transplanting the cationic and hydrophobic hairpin sequence onto a template, whose function is to restrain the peptide loop backbone into a hairpin geometry. The rigidity of the hairpin may be further influenced by introducing a disulfide bridge. Template-bound hairpin mimetic peptides have been described in the literature (D. Obrecht, M. Altorfer, J. A. Robinson, *Adv. Med. Chem.* **1999**, *4*, 1-68; J. A. Robinson, *Syn. Lett.* **2000**, *4*, 429-441), but such molecules have not previously been evaluated for development of CXCR4 antagonizing peptides. However, the ability to generate β -hairpin peptidomimetics using combinatorial and parallel synthesis methods has now been established (L. Jiang, K. Moehle, B. Dhanapal, D. Obrecht, J. A. Robinson, *Helv. Chim. Acta.* **2000**, *83*, 3097-3112).

These methods allow the synthesis and screening of large hairpin mimetic libraries, which in turn considerably facilitates structure-activity studies, and hence the discovery of new molecules with highly potent CXCR4 antagonizing activity or anti cancer activity or anti inflammatory activity and low hemolytic activity to human red blood blood cells. β -Hairpin

peptidomimetics obtained by the approach described here are useful as Anti-HIV agents and anticancer agents and anti-inflammatory agents.

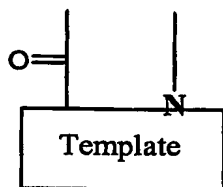
The β -hairpin peptidomimetics of the present invention are compounds of the general formula

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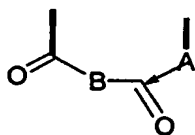


(I)

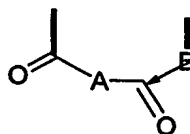
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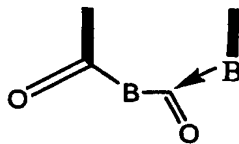
10 is a group of one of the formulae



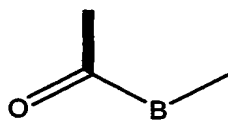
(a1)



(a2)

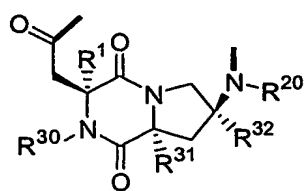


(a3)

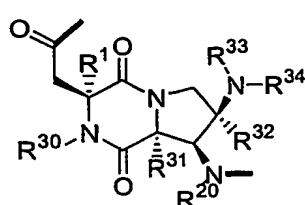


(a4)

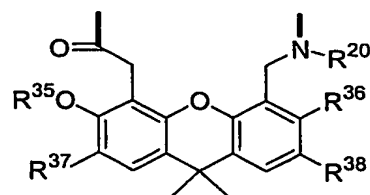
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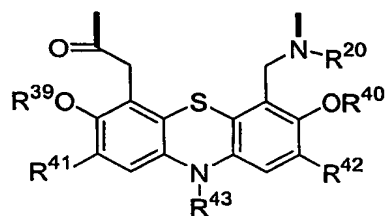
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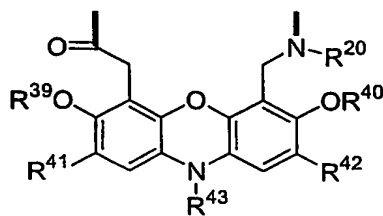
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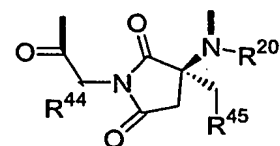
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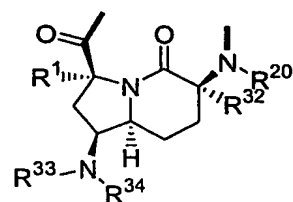
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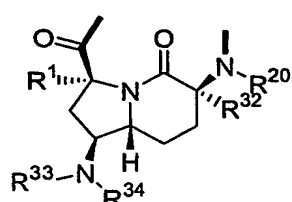
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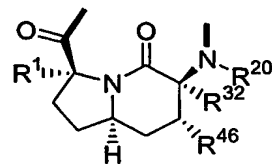
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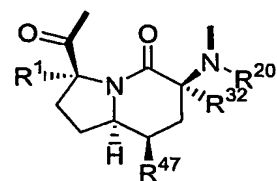
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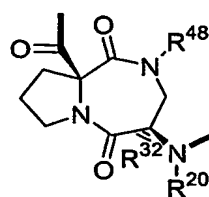
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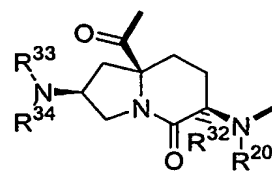
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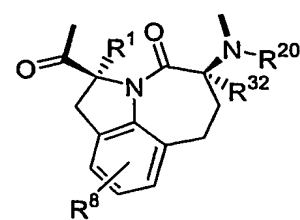
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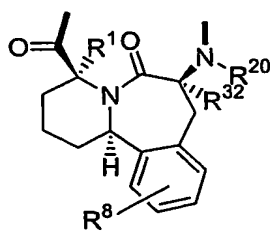
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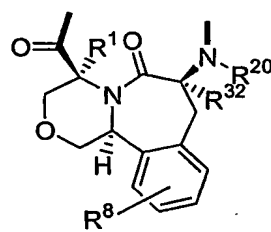
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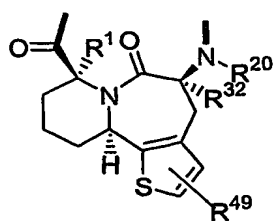
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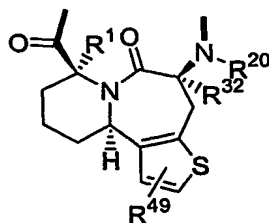
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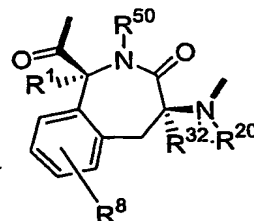
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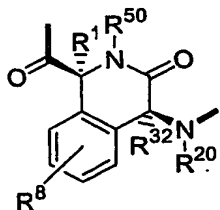
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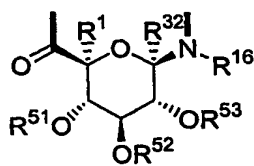
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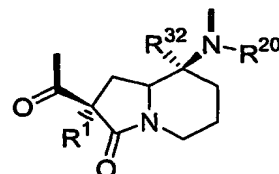
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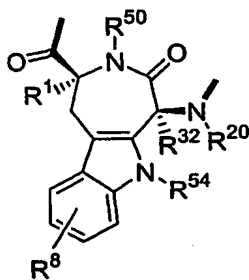
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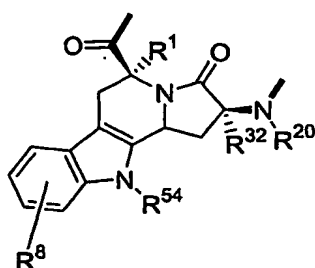
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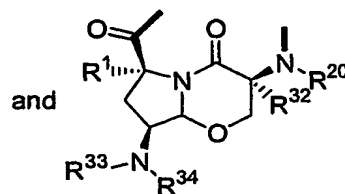
(m)



(n)

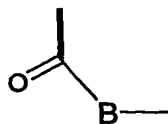


(o)



(p)

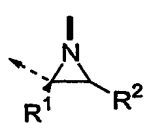
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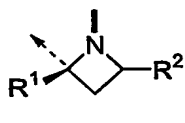
5 is the residue of an L- α -amino acid with B being a residue of formula $-\text{NR}^{20}\text{CH}(\text{R}^{71})-$; or the enantiomer of one of the groups A1 to A69 as defined hereinafter; or, in case the template is of type (a4), also a residue of an amino acid with B being a residue of formula $-\text{NR}^{20}-\text{CH}_2-\text{C}_6\text{H}_4-\text{CH}_2-$;



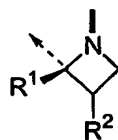
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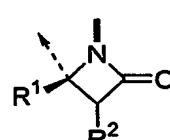
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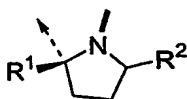
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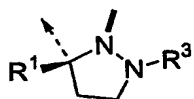
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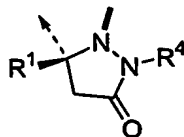
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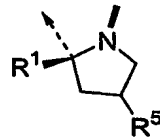
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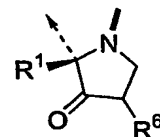
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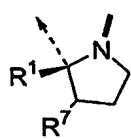
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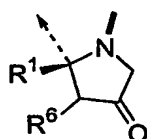
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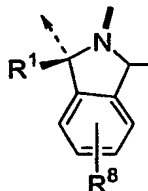
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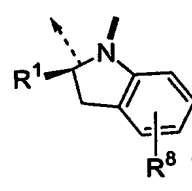
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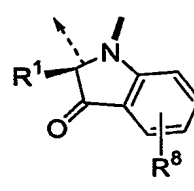
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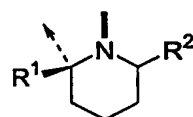
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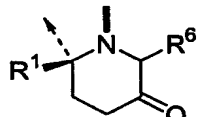
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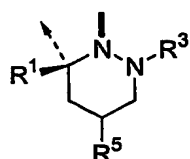
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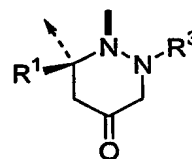
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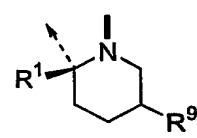
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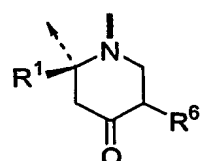
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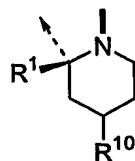
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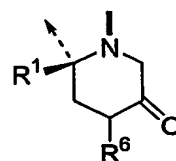
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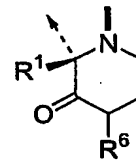
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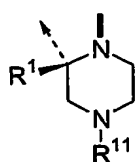
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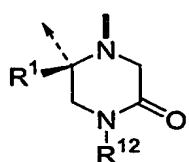
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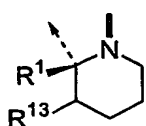
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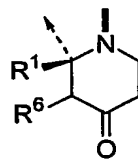
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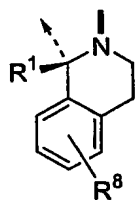
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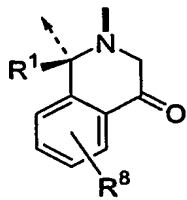
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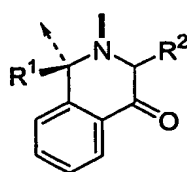
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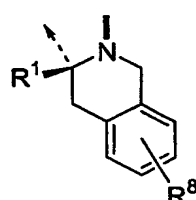
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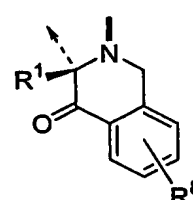
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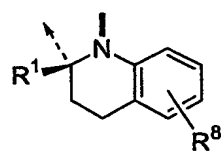
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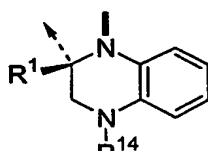
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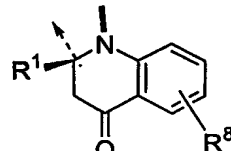
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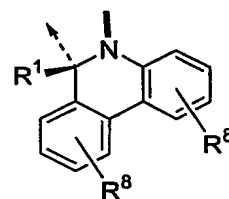
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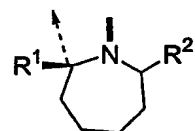
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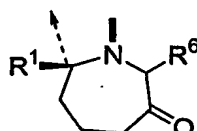
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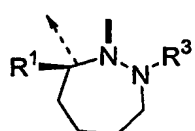
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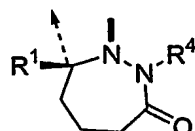
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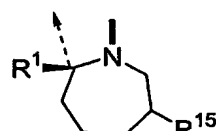
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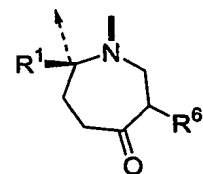
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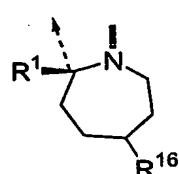
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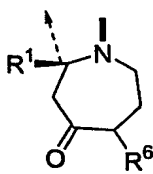
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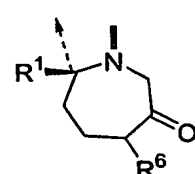
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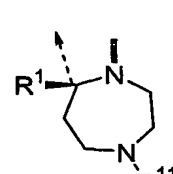
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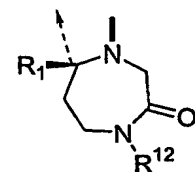
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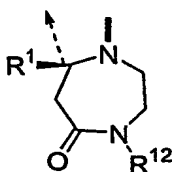
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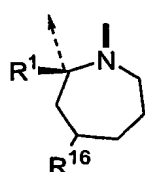
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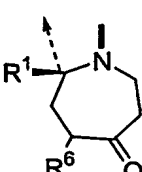
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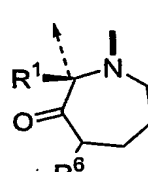
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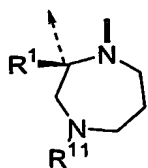
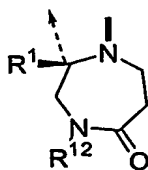
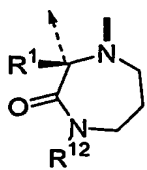
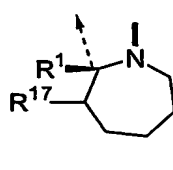
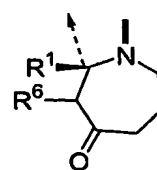
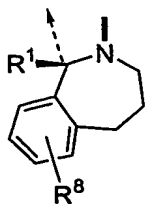
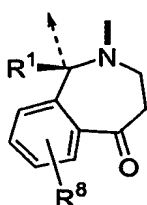
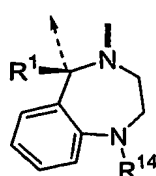
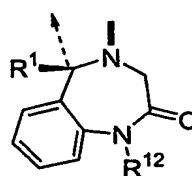
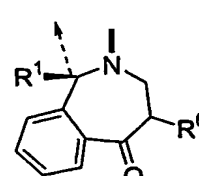
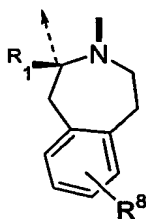
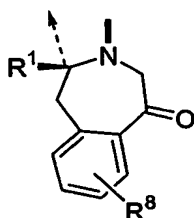
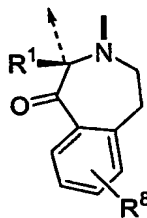
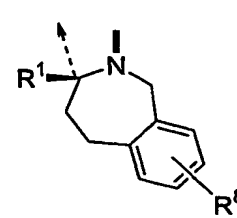
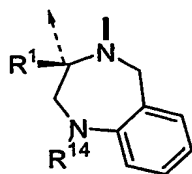
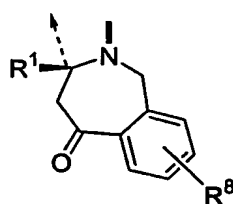
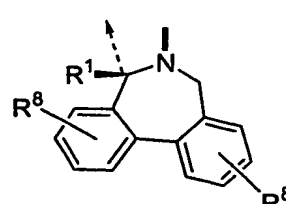
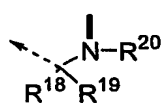
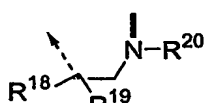
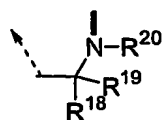
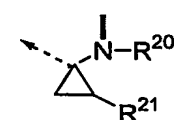
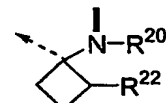
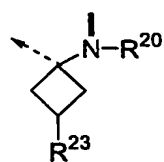
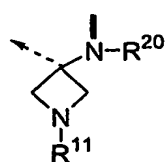
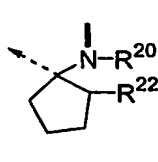
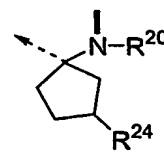
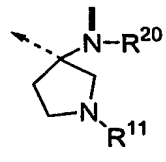
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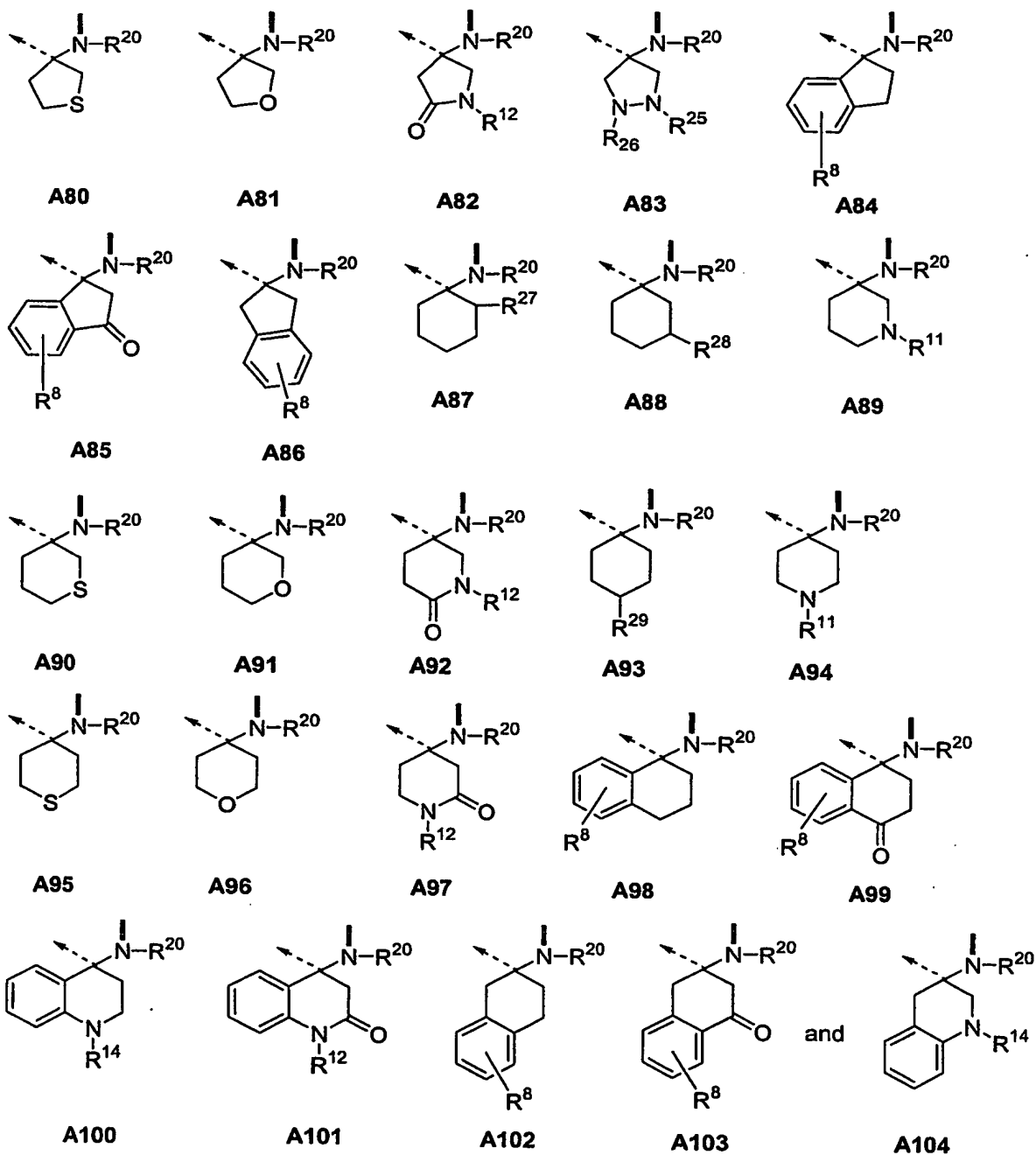


A51



A52

**A53****A54****A55****A56****A57****A58****A59****A60****A61****A62****A63****A64****A65****A66****A67****A68****A69****A70****A71****A72****A73****A74****A75****A76****A77****A78****A79**



R^1 is H; lower alkyl; or aryl-lower alkyl;

R^2 is H; alkyl; alkenyl; $-(CH_2)_m(CHR^{61})_sOR^{55}$; $-(CH_2)_m(CHR^{61})_sSR^{56}$;
 $-(CH_2)_m(CHR^{61})_sNR^{33}R^{34}$; $-(CH_2)_m(CHR^{61})_sOCONR^{33}R^{75}$;
 $-(CH_2)_m(CHR^{61})_sNR^{20}CONR^{33}R^{82}$; $-(CH_2)_o(CHR^{61})_sCOOR^{57}$;

- $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$;
 $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
 R³ is H; alkyl; alkenyl; $-(CH_2)_m(CHR^{61})_sOR^{55}$; $-(CH_2)_m(CHR^{61})_sSR^{56}$;
 $-(CH_2)_m(CHR^{61})_sNR^{33}R^{34}$; $-(CH_2)_m(CHR^{61})_sOCONR^{33}R^{75}$;
 5 $-(CH_2)_m(CHR^{61})_sNR^{20}CONR^{33}R^{82}$; $-(CH_2)_o(CHR^{61})_sCOOR^{57}$;
 $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$;
 $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
 R⁴ is H; alkyl; alkenyl; $-(CH_2)_m(CHR^{61})_sOR^{55}$; $-(CH_2)_m(CHR^{61})_sSR^{56}$; -
 $(CH_2)_m(CHR^{61})_sNR^{33}R^{34}$;
 10 $-(CH_2)_m(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_m(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
 $-(CH_2)_p(CHR^{61})_sCOOR^{57}$; $-(CH_2)_p(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_p(CHR^{61})_sPO(OR^{60})_2$;
 $-(CH_2)_p(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
 R⁵ is alkyl; alkenyl; $-(CH_2)_o(CHR^{61})_sOR^{55}$; $-(CH_2)_o(CHR^{61})_sSR^{56}$; $-(CH_2)_o(CHR^{61})_sNR^{33}R^{34}$;
 $-(CH_2)_o(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_o(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
 15 $-(CH_2)_o(CHR^{61})_sCOOR^{57}$; $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$;
 $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
 R⁶ is H; alkyl; alkenyl; $-(CH_2)_o(CHR^{61})_sOR^{55}$; $-(CH_2)_o(CHR^{61})_sSR^{56}$; -
 $(CH_2)_o(CHR^{61})_sNR^{33}R^{34}$;
 $-(CH_2)_o(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_o(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
 20 $-(CH_2)_o(CHR^{61})_sCOOR^{57}$; $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$;
 $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
 R⁷ is alkyl; alkenyl; $-(CH_2)_q(CHR^{61})_sOR^{55}$; $-(CH_2)_q(CHR^{61})_sNR^{33}R^{34}$;
 $-(CH_2)_q(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_q(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
 $-(CH_2)_r(CHR^{61})_sCOOR^{57}$; $-(CH_2)_r(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_r(CHR^{61})_sPO(OR^{60})_2$;
 25 $-(CH_2)_r(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_r(CHR^{61})_sC_6H_4R^8$;
 R⁸ is H; Cl; F; CF₃; NO₂; lower alkyl; lower alkenyl; aryl; aryl-lower alkyl;
 $-(CH_2)_o(CHR^{61})_sOR^{55}$; $-(CH_2)_o(CHR^{61})_sSR^{56}$; $-(CH_2)_o(CHR^{61})_sNR^{33}R^{34}$;
 $-(CH_2)_o(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_o(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
 $-(CH_2)_o(CHR^{61})_sCOOR^{57}$; $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$;
 30 $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sCOR^{64}$;
 R⁹ is alkyl; alkenyl; $-(CH_2)_o(CHR^{61})_sOR^{55}$; $-(CH_2)_o(CHR^{61})_sSR^{56}$; $-(CH_2)_o(CHR^{61})_sNR^{33}R^{34}$;
 $-(CH_2)_o(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_o(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
 $-(CH_2)_o(CHR^{61})_sCOOR^{57}$; $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$;
 $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;

- R^{10} is alkyl; alkenyl; $-(CH_2)_o(CHR^{61})_sOR^{55}$; $-(CH_2)_o(CHR^{61})_sSR^{56}$; $-(CH_2)_o(CHR^{61})_sNR^{33}R^{34}$; $-(CH_2)_o(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_o(CHR^{61})_sNR^{20}CONR^{33}R^{82}$; $-(CH_2)_o(CHR^{61})_sCOOR^{57}$; $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$; $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
- 5 R^{11} is H; alkyl; alkenyl; $-(CH_2)_m(CHR^{61})_sOR^{55}$; $-(CH_2)_m(CHR^{61})_sNR^{33}R^{34}$; $-(CH_2)_m(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_m(CHR^{61})_sNR^{20}CONR^{33}R^{82}$; $-(CH_2)_o(CHR^{61})_sCOOR^{57}$; $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$; $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
- 10 R^{12} is H; alkyl; alkenyl; $-(CH_2)_m(CHR^{61})_sOR^{55}$; $-(CH_2)_m(CHR^{61})_sSR^{56}$; $-(CH_2)_m(CHR^{61})_sNR^{33}R^{34}$; $-(CH_2)_m(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_m(CHR^{61})_sNR^{20}CONR^{33}R^{82}$; $-(CH_2)_r(CHR^{61})_sCOOR^{57}$; $-(CH_2)_r(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_r(CHR^{61})_sPO(OR^{60})_2$; $-(CH_2)_r(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_r(CHR^{61})_sC_6H_4R^8$;
- 15 R^{13} is alkyl; alkenyl; $-(CH_2)_q(CHR^{61})_sOR^{55}$; $-(CH_2)_q(CHR^{61})_sSR^{56}$; $-(CH_2)_q(CHR^{61})_sNR^{33}R^{34}$; $-(CH_2)_q(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_q(CHR^{61})_sNR^{20}CONR^{33}R^{82}$; $-(CH_2)_q(CHR^{61})_sCOOR^{57}$; $-(CH_2)_q(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_q(CHR^{61})_sPO(OR^{60})_2$; $-(CH_2)_q(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_q(CHR^{61})_sC_6H_4R^8$;
- 20 R^{14} is H; alkyl; alkenyl; $-(CH_2)_m(CHR^{61})_sOR^{55}$; $-(CH_2)_m(CHR^{61})_sNR^{33}R^{34}$; $-(CH_2)_m(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_m(CHR^{61})_sNR^{20}CONR^{33}R^{82}$; $-(CH_2)_q(CHR^{61})_sCOOR^{57}$; $-(CH_2)_q(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_q(CHR^{61})_sPO(OR^{60})_2$; $-(CH_2)_q(CHR^{61})_sSOR^{62}$; or $-(CH_2)_q(CHR^{61})_sC_6H_4R^8$;
- 25 R^{15} is alkyl; alkenyl; $-(CH_2)_o(CHR^{61})_sOR^{55}$; $-(CH_2)_o(CHR^{61})_sSR^{56}$; $-(CH_2)_o(CHR^{61})_sNR^{33}R^{34}$; $-(CH_2)_o(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_o(CHR^{61})_sNR^{20}CONR^{33}R^{82}$; $-(CH_2)_o(CHR^{61})_sCOOR^{57}$; $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$; $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
- 30 R^{16} is alkyl; alkenyl; $-(CH_2)_o(CHR^{61})_sOR^{55}$; $-(CH_2)_o(CHR^{61})_sSR^{56}$; $-(CH_2)_o(CHR^{61})_sNR^{33}R^{34}$; $-(CH_2)_o(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_o(CHR^{61})_sNR^{20}CONR^{33}R^{82}$; $-(CH_2)_o(CHR^{61})_sCOOR^{57}$; $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$; $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
- R^{17} is alkyl; alkenyl; $-(CH_2)_q(CHR^{61})_sOR^{55}$; $-(CH_2)_q(CHR^{61})_sSR^{56}$; $-(CH_2)_q(CHR^{61})_sNR^{33}R^{34}$; $-(CH_2)_q(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_q(CHR^{61})_sNR^{20}CONR^{33}R^{82}$; $-(CH_2)_q(CHR^{61})_sCOOR^{57}$; $-(CH_2)_q(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_q(CHR^{61})_sPO(OR^{60})_2$; $-(CH_2)_q(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_q(CHR^{61})_sC_6H_4R^8$;
- R^{18} is alkyl; alkenyl; $-(CH_2)_p(CHR^{61})_sOR^{55}$; $-(CH_2)_p(CHR^{61})_sSR^{56}$; $-(CH_2)_p(CHR^{61})_sNR^{33}R^{34}$;

- $-(CH_2)_p(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_p(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
 $-(CH_2)_p(CHR^{61})_sCOOR^{57}$; $-(CH_2)_p(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_p(CHR^{61})_sPO(OR^{60})_2$;
 $-(CH_2)_p(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
 5 R^{19} is lower alkyl; $-(CH_2)_p(CHR^{61})_sOR^{55}$; $-(CH_2)_p(CHR^{61})_sSR^{56}$; $-(CH_2)_p(CHR^{61})_sNR^{33}R^{34}$;
 $-(CH_2)_p(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_p(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
 $-(CH_2)_p(CHR^{61})_sCOOR^{57}$; $-(CH_2)_p(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_p(CHR^{61})_sPO(OR^{60})_2$;
 $-(CH_2)_p(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$; or
 R^{18} and R^{19} taken together can form: $-(CH_2)_{2-6}$; $-(CH_2)_2O(CH_2)_2$; $-(CH_2)_2S(CH_2)_2$; or
 $-(CH_2)_2NR^{57}(CH_2)_2$;
 10 R^{20} is H; alkyl; alkenyl; or aryl-lower alkyl;
 R^{21} is H; alkyl; alkenyl; $-(CH_2)_o(CHR^{61})_sOR^{55}$; $-(CH_2)_o(CHR^{61})_sSR^{56}$; -
 $(CH_2)_o(CHR^{61})_sNR^{33}R^{34}$;
 $-(CH_2)_o(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_o(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
 $-(CH_2)_o(CHR^{61})_sCOOR^{57}$; $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$;
 15 $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
 R^{22} is H; alkyl; alkenyl; $-(CH_2)_o(CHR^{61})_sOR^{55}$; $-(CH_2)_o(CHR^{61})_sSR^{56}$; -
 $(CH_2)_o(CHR^{61})_sNR^{33}R^{34}$;
 $-(CH_2)_o(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_o(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
 $-(CH_2)_o(CHR^{61})_sCOOR^{57}$; $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$;
 20 $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
 R^{23} is alkyl; alkenyl; $-(CH_2)_o(CHR^{61})_sOR^{55}$; $-(CH_2)_o(CHR^{61})_sSR^{56}$; $-(CH_2)_o(CHR^{61})_sNR^{33}R^{34}$;
 $-(CH_2)_o(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_o(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
 $-(CH_2)_o(CHR^{61})_sCOOR^{57}$; $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$;
 $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
 25 R^{24} is alkyl; alkenyl; $-(CH_2)_o(CHR^{61})_sOR^{55}$; $-(CH_2)_o(CHR^{61})_sSR^{56}$; $-(CH_2)_o(CHR^{61})_sNR^{33}R^{34}$;
 $-(CH_2)_o(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_o(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
 $-(CH_2)_o(CHR^{61})_sCOOR^{57}$; $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$;
 $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
 R^{25} is H; alkyl; alkenyl; $-(CH_2)_m(CHR^{61})_sOR^{55}$; $-(CH_2)_m(CHR^{61})_sSR^{56}$;
 30 $-(CH_2)_m(CHR^{61})_sNR^{33}R^{34}$; $-(CH_2)_m(CHR^{61})_sOCONR^{33}R^{75}$;
 $-(CH_2)_m(CHR^{61})_sNR^{20}CONR^{33}R^{82}$; $-(CH_2)_o(CHR^{61})_sCOOR^{57}$;
 $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$;
 $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
 R^{26} is H; alkyl; alkenyl; $-(CH_2)_m(CHR^{61})_sOR^{55}$; $-(CH_2)_m(CHR^{61})_sSR^{56}$;

- $-(CH_2)_m(CHR^{61})_sNR^{33}R^{34}$; $-(CH_2)_m(CHR^{61})_sOCONR^{33}R^{75}$;
 $-(CH_2)_m(CHR^{61})_sNR^{20}CONR^{33}R^{82}$; $-(CH_2)_o(CHR^{61})_sCOOR^{57}$; -
 $(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$;
 $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$; or
5 R^{25} and R^{26} taken together can form: $-(CH_2)_{2-6}$; $-(CH_2)_rO(CH_2)_r$; $-(CH_2)_rS(CH_2)_r$; or
 $-(CH_2)_rNR^{57}(CH_2)_r$;
 R^{27} is H; alkyl; alkenyl; $-(CH_2)_o(CHR^{61})_sOR^{55}$; $-(CH_2)_o(CHR^{61})_sSR^{56}$; -
 $(CH_2)_o(CHR^{61})_sNR^{33}R^{34}$;
 $-(CH_2)_o(CHR^{61})_sCOOR^{57}$; $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sOCONR^{33}R^{75}$;
10 $-(CH_2)_o(CHR^{61})_sNR^{20}CONR^{33}R^{82}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$;
 $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
 R^{28} is alkyl; alkenyl; $-(CH_2)_o(CHR^{61})_sOR^{55}$; $-(CH_2)_o(CHR^{61})_sSR^{56}$; $-(CH_2)_o(CHR^{61})_s$
 $NR^{33}R^{34}$;
 $-(CH_2)_o(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_o(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
15 $-(CH_2)_o(CHR^{61})_sCOOR^{57}$; $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$;
 $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
 R^{29} is alkyl; alkenyl; $-(CH_2)_o(CHR^{61})_sOR^{55}$; $-(CH_2)_o(CHR^{61})_sSR^{56}$; $-(CH_2)_o(CHR^{61})_sNR^{33}R^{34}$;
 $-(CH_2)_o(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_o(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
 $-(CH_2)_o(CHR^{61})_sCOOR^{57}$; $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$;
20 $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
 R^{30} is H; alkyl; alkenyl; or aryl-lower alkyl;
 R^{31} is H; alkyl; alkenyl; $-(CH_2)_p(CHR^{61})_sOR^{55}$; $-(CH_2)_p(CHR^{61})_sNR^{33}R^{34}$;
 $-(CH_2)_p(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_p(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
 $-(CH_2)_o(CHR^{61})_sCOOR^{57}$; $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$;
25 $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
 R^{32} is H; lower alkyl; or aryl-lower alkyl;
 R^{33} is H; alkyl; alkenyl; $-(CH_2)_m(CHR^{61})_sOR^{55}$; $-(CH_2)_m(CHR^{61})_sNR^{34}R^{63}$;
 $-(CH_2)_m(CHR^{61})_sOCONR^{75}R^{82}$; $-(CH_2)_m(CHR^{61})_sNR^{20}CONR^{78}R^{82}$;
 $-(CH_2)_o(CHR^{61})_sCOR^{64}$; $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$;
30 $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
 R^{34} is H; lower alkyl; aryl, or aryl-lower alkyl;
 R^{33} and R^{34} taken together can form: $-(CH_2)_{2-6}$; $-(CH_2)_2O(CH_2)_2$; $-(CH_2)_2S(CH_2)_2$; or
 $-(CH_2)_2NR^{57}(CH_2)_2$;
 R^{35} is H; alkyl; alkenyl; $-(CH_2)_m(CHR^{61})_sOR^{55}$; $-(CH_2)_m(CHR^{61})_sNR^{33}R^{34}$;

- $-(CH_2)_m(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_m(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
 $-(CH_2)_p(CHR^{61})_sCOOR^{57}$; $-(CH_2)_p(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_p(CHR^{61})_sPO(OR^{60})_2$;
 $-(CH_2)_p(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_p(CHR^{61})_sC_6H_4R^8$;
 5 R^{36} is H, alkyl; alkenyl; $-(CH_2)_o(CHR^{61})_sOR^{55}$; $-(CH_2)_p(CHR^{61})_sNR^{33}R^{34}$;
 $-(CH_2)_p(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_p(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
 $-(CH_2)_p(CHR^{61})_sCOOR^{57}$; $-(CH_2)_p(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_p(CHR^{61})_sPO(OR^{60})_2$;
 $-(CH_2)_p(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
 R^{37} is H; F; Br; Cl; NO_2 ; CF_3 ; lower alkyl; $-(CH_2)_p(CHR^{61})_sOR^{55}$; $-(CH_2)_p(CHR^{61})_sNR^{33}R^{34}$;
 10 $-(CH_2)_p(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_p(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
 $-(CH_2)_o(CHR^{61})_sCOOR^{57}$; $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$;
 $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
 R^{38} is H; F; Br; Cl; NO_2 ; CF_3 ; alkyl; alkenyl; $-(CH_2)_p(CHR^{61})_sOR^{55}$; $-(CH_2)_p(CHR^{61})_sNR^{33}R^{34}$;
 $-(CH_2)_p(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_p(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
 $-(CH_2)_o(CHR^{61})_sCOOR^{57}$; $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$;
 15 $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
 R^{39} is H; alkyl; alkenyl; or aryl-lower alkyl;
 R^{40} is H; alkyl; alkenyl; or aryl-lower alkyl;
 R^{41} is H; F; Br; Cl; NO_2 ; CF_3 ; alkyl; alkenyl; $-(CH_2)_p(CHR^{61})_sOR^{55}$; $-(CH_2)_p(CHR^{61})_sNR^{33}R^{34}$;
 $-(CH_2)_p(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_p(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
 20 $-(CH_2)_o(CHR^{61})_sCOOR^{57}$; $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$;
 $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
 R^{42} is H; F; Br; Cl; NO_2 ; CF_3 ; alkyl; alkenyl; $-(CH_2)_p(CHR^{61})_sOR^{55}$; $-(CH_2)_p(CHR^{61})_sNR^{33}R^{34}$;
 $-(CH_2)_p(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_p(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
 $-(CH_2)_o(CHR^{61})_sCOOR^{57}$; $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$;
 25 $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
 R^{43} is H; alkyl; alkenyl; $-(CH_2)_m(CHR^{61})_sOR^{55}$; $-(CH_2)_m(CHR^{61})_sNR^{33}R^{34}$;
 $-(CH_2)_m(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_m(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
 $-(CH_2)_o(CHR^{61})_sCOOR^{57}$; $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_sPO(OR^{60})_2$;
 $-(CH_2)_o(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
 30 R^{44} is alkyl; alkenyl; $-(CH_2)_r(CHR^{61})_sOR^{55}$; $-(CH_2)_r(CHR^{61})_sSR^{56}$; $-(CH_2)_r(CHR^{61})_sNR^{33}R^{34}$;
 $-(CH_2)_r(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_r(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
 $-(CH_2)_r(CHR^{61})_sCOOR^{57}$; $-(CH_2)_r(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_r(CHR^{61})_sPO(OR^{60})_2$;
 $-(CH_2)_r(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_r(CHR^{61})_sC_6H_4R^8$;

- R^{45} is H; alkyl; alkenyl; $-(CH_2)_o(CHR^{61})_sOR^{55}$; $-(CH_2)_o(CHR^{61})_sSR^{56}$; -
 $(CH_2)_o(CHR^{61})_sNR^{33}R^{34}$;
 $-(CH_2)_o(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_o(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
 $-(CH_2)_o(CHR^{61})_sCOOR^{57}$; $-(CH_2)_s(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_s(CHR^{61})_sPO(OR^{60})_2$;
 5 $-(CH_2)_s(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_s(CHR^{61})_sC_6H_4R^8$;
 R^{46} is H; alkyl; alkenyl; or $-(CH_2)_o(CHR^{61})_pC_6H_4R^8$;
 R^{47} is H; alkyl; alkenyl; or $-(CH_2)_o(CHR^{61})_sOR^{55}$;
 R^{48} is H; lower alkyl; lower alkenyl; or aryl-lower alkyl;
 R^{49} is H; alkyl; alkenyl; $-(CHR^{61})_sCOOR^{57}$; $(CHR^{61})_sCONR^{58}R^{59}$; $(CHR^{61})_sPO(OR^{60})_2$;
 10 $-(CHR^{61})_sSOR^{62}$; or $-(CHR^{61})_sC_6H_4R^8$;
 R^{50} is H; lower alkyl; or aryl-lower alkyl;
 R^{51} is H; alkyl; alkenyl; $-(CH_2)_m(CHR^{61})_sOR^{55}$; $-(CH_2)_m(CHR^{61})_sSR^{56}$;
 $-(CH_2)_m(CHR^{61})_sNR^{33}R^{34}$; $-(CH_2)_m(CHR^{61})_sOCONR^{33}R^{75}$;
 $-(CH_2)_m(CHR^{61})_sNR^{20}CONR^{33}R^{82}$; $-(CH_2)_o(CHR^{61})_sCOOR^{57}$;
 15 $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_pPO(OR^{60})_2$;
 $-(CH_2)_p(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_p(CHR^{61})_sC_6H_4R^8$;
 R^{52} is H; alkyl; alkenyl; $-(CH_2)_m(CHR^{61})_sOR^{55}$; $-(CH_2)_m(CHR^{61})_sSR^{56}$;
 $-(CH_2)_m(CHR^{61})_sNR^{33}R^{34}$; $-(CH_2)_m(CHR^{61})_sOCONR^{33}R^{75}$;
 $-(CH_2)_m(CHR^{61})_sNR^{20}CONR^{33}R^{82}$; $-(CH_2)_o(CHR^{61})_sCOOR^{57}$;
 20 $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_pPO(OR^{60})_2$;
 $-(CH_2)_p(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_p(CHR^{61})_sC_6H_4R^8$;
 R^{53} is H; alkyl; alkenyl; $-(CH_2)_m(CHR^{61})_sOR^{55}$; $-(CH_2)_m(CHR^{61})_sSR^{56}$; -
 $(CH_2)_m(CHR^{61})_sNR^{33}R^{34}$; $-(CH_2)_m(CHR^{61})_sOCONR^{33}R^{75}$;
 $-(CH_2)_m(CHR^{61})_sNR^{20}CONR^{33}R^{82}$; $-(CH_2)_o(CHR^{61})_sCOOR^{57}$;
 25 $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; $-(CH_2)_o(CHR^{61})_pPO(OR^{60})_2$;
 $-(CH_2)_p(CHR^{61})_sSO_2R^{62}$; or $-(CH_2)_p(CHR^{61})_sC_6H_4R^8$;
 R^{54} is H; alkyl; alkenyl; $-(CH_2)_m(CHR^{61})_sOR^{55}$; $-(CH_2)_m(CHR^{61})_sNR^{33}R^{34}$;
 $-(CH_2)_m(CHR^{61})_sOCONR^{33}R^{75}$; $-(CH_2)_m(CHR^{61})_sNR^{20}CONR^{33}R^{82}$;
 $-(CH_2)_o(CHR^{61})_sCOOR^{57}$; $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$; or $-(CH_2)_o(CHR^{61})_sC_6H_4R^8$;
 30 R^{55} is H; lower alkyl; lower alkenyl; aryl-lower alkyl; $-(CH_2)_m(CHR^{61})_sOR^{57}$;
 $-(CH_2)_m(CHR^{61})_sNR^{34}R^{63}$; $-(CH_2)_m(CHR^{61})_sOCONR^{75}R^{82}$;
 $-(CH_2)_m(CHR^{61})_sNR^{20}CONR^{78}R^{82}$; $-(CH_2)_o(CHR^{61})_s-COR^{64}$; $-(CH_2)_o(CHR^{61})_sCOOR^{57}$;
 or
 $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$;

- R^{56} is H; lower alkyl; lower alkenyl; aryl-lower alkyl; $-(CH_2)_m(CHR^{61})_sOR^{57}$;
 $-(CH_2)_m(CHR^{61})_sNR^{34}R^{63}$; $-(CH_2)_m(CHR^{61})_sOCONR^{75}R^{82}$;
 $-(CH_2)_m(CHR^{61})_sNR^{20}CONR^{78}R^{82}$; $-(CH_2)_o(CHR^{61})_s-COR^{64}$; or
 $-(CH_2)_o(CHR^{61})_sCONR^{58}R^{59}$;
- 5 R^{57} is H; lower alkyl; lower alkenyl; aryl lower alkyl; or heteroaryl lower alkyl;
 R^{58} is H; lower alkyl; lower alkenyl; aryl; heteroaryl; aryl-lower alkyl; or heteroaryl-lower alkyl;
 R^{59} is H; lower alkyl; lower alkenyl; aryl; heteroaryl; aryl-lower alkyl; or heteroaryl-lower alkyl; or
- 10 R^{58} and R^{59} taken together can form: $-(CH_2)_{2-6}$; $-(CH_2)_2O(CH_2)_2$; $-(CH_2)_2S(CH_2)_2$; or
 $-(CH_2)_2NR^{57}(CH_2)_2$;
- R^{60} is H; lower alkyl; lower alkenyl; aryl; or aryl-lower alkyl;
 R^{61} is alkyl; alkenyl; aryl; heteroaryl; aryl-lower alkyl; heteroaryl-lower alkyl; $-(CH_2)_mOR^{55}$;
 $-(CH_2)_mNR^{33}R^{34}$; $-(CH_2)_mOCONR^{75}R^{82}$; $-(CH_2)_mNR^{20}CONR^{78}R^{82}$; $-(CH_2)_oCOOR^{37}$;
15 $-(CH_2)_oNR^{58}R^{59}$; or $-(CH_2)_oPO(COR^{60})_2$;
- R^{62} is lower alkyl; lower alkenyl; aryl, heteroaryl; or aryl-lower alkyl;
 R^{63} is H; lower alkyl; lower alkenyl; aryl, heteroaryl; aryl-lower alkyl; heteroaryl-lower alkyl;
 $-COR^{64}$; $-COOR^{57}$; $-CONR^{58}R^{59}$; $-SO_2R^{62}$; or $-PO(OR^{60})_2$;
- R^{34} and R^{63} taken together can form: $-(CH_2)_{2-6}$; $-(CH_2)_2O(CH_2)_2$; $-(CH_2)_2S(CH_2)_2$; or
20 $-(CH_2)_2NR^{57}(CH_2)_2$;
- R^{64} is H; lower alkyl; lower alkenyl; aryl; heteroaryl; aryl-lower alkyl; heteroaryl-lower alkyl;
 $-(CH_2)_p(CHR^{61})_sOR^{65}$; $-(CH_2)_p(CHR^{61})_sSR^{66}$; or $-(CH_2)_p(CHR^{61})_sNR^{34}R^{63}$;
 $-(CH_2)_p(CHR^{61})_sOCONR^{75}R^{82}$; $-(CH_2)_p(CHR^{61})_sNR^{20}CONR^{78}R^{82}$;
- R^{65} is H; lower alkyl; lower alkenyl; aryl, aryl-lower alkyl; heteroaryl-lower alkyl; $-COR^{57}$;
25 $-COOR^{57}$; or $-CONR^{58}R^{59}$;
- R^{66} is H; lower alkyl; lower alkenyl; aryl; aryl-lower alkyl; heteroaryl-lower alkyl; or
 $-CONR^{58}R^{59}$;

- Z and Z^1 are chains of n and, respectively, n' α -amino acid residues whereby either n is 4 and n'
30 is 6 or n is 5 and n' is 7, the positions of said amino acid residues in said chain Z being counted starting from the N-terminal amino acid and the positions of said amino acid residues in said chain Z^1 being counted starting from the C-terminal amino acid, whereby these amino acid residues are, depending on their position in the chains, Gly, or Pro, or of one of the types

- C: $-\text{NR}^{20}\text{CH}(\text{R}^{72})\text{CO}-$;
 D: $-\text{NR}^{20}\text{CH}(\text{R}^{73})\text{CO}-$;
 E: $-\text{NR}^{20}\text{CH}(\text{R}^{74})\text{CO}-$;
 F: $-\text{NR}^{20}\text{CH}(\text{R}^{84})\text{CO}-$; and
 5 H: $-\text{NR}^{20}-\text{CH}(\text{CO}-)(\text{CH}_2)_{4-7}-\text{CH}(\text{CO}-)-\text{NR}^{20}-$;
 $-\text{NR}^{20}-\text{CH}(\text{CO}-)(\text{CH}_2)_p\text{SS}(\text{CH}_2)_p-\text{CH}(\text{CO}-)-\text{NR}^{20}-$;
 $-\text{NR}^{20}-\text{CH}(\text{CO}-)-(\text{CH}_2)_p\text{NR}^{20}\text{CO}(\text{CH}_2)_p-\text{CH}(\text{CO}-)-\text{NR}^{20}-$;
 $-\text{NR}^{20}-\text{CH}(\text{CO}-)-(\text{CH}_2)_p\text{NR}^{20}\text{CONR}^{20}(\text{CH}_2)_p-\text{CH}(\text{CO}-)-\text{NR}^{20}-$; and
 I: $-\text{NR}^{86}\text{CH}_2\text{CO}-$;
 10 R^{71} is lower alkenyl; $-(\text{CH}_2)_p(\text{CHR}^{61})_s\text{OR}^{75}$; $-(\text{CH}_2)_p(\text{CHR}^{61})_s\text{SR}^{75}$;
 $-(\text{CH}_2)_p(\text{CHR}^{61})_s\text{OCONR}^{33}\text{R}^{75}$;
 $-(\text{CH}_2)_o(\text{CHR}^{61})_s\text{COOR}^{75}$; $-(\text{CH}_2)_p\text{CONR}^{58}\text{R}^{59}$; $-(\text{CH}_2)_p\text{PO}(\text{OR}^{62})_2$; $-(\text{CH}_2)_p\text{SO}_2\text{R}^{62}$; or
 $-(\text{CH}_2)_o-\text{C}_6\text{R}^{67}\text{R}^{68}\text{R}^{69}\text{R}^{70}\text{R}^{76}$;
 R^{72} is H, lower alkyl; lower alkenyl; $-(\text{CH}_2)_p(\text{CHR}^{61})_s\text{OR}^{85}$; or $-(\text{CH}_2)_p(\text{CHR}^{61})_s\text{SR}^{85}$;
 15 R^{73} is $-(\text{CH}_2)_o\text{R}^{77}$; $-(\text{CH}_2)_r\text{O}(\text{CH}_2)_o\text{R}^{77}$; $-(\text{CH}_2)_r\text{S}(\text{CH}_2)_o\text{R}^{77}$; or $-(\text{CH}_2)_r\text{NR}^{20}(\text{CH}_2)_o\text{R}^{77}$;
 R^{74} is $-(\text{CH}_2)_p\text{NR}^{78}\text{R}^{79}$; $-(\text{CH}_2)_p\text{NR}^{77}\text{R}^{80}$; $-(\text{CH}_2)_p\text{C}(=\text{NR}^{80})\text{NR}^{78}\text{R}^{79}$; $-(\text{CH}_2)_p\text{C}(=\text{NOR}^{50})\text{NR}^{78}\text{R}^{79}$;
 $-(\text{CH}_2)_p\text{C}(=\text{NNR}^{78}\text{R}^{79})\text{NR}^{78}\text{R}^{79}$; $-(\text{CH}_2)_p\text{NR}^{80}\text{C}(=\text{NR}^{80})\text{NR}^{78}\text{R}^{79}$;
 $-(\text{CH}_2)_p\text{N}=\text{C}(\text{NR}^{78}\text{R}^{80})\text{NR}^{79}\text{R}^{80}$; $-(\text{CH}_2)_p\text{C}_6\text{H}_4\text{NR}^{78}\text{R}^{79}$; $-(\text{CH}_2)_p\text{C}_6\text{H}_4\text{NR}^{77}\text{R}^{80}$;
 $-(\text{CH}_2)_p\text{C}_6\text{H}_4\text{C}(=\text{NR}^{80})\text{NR}^{78}\text{R}^{79}$; $-(\text{CH}_2)_p\text{C}_6\text{H}_4\text{C}(=\text{NOR}^{50})\text{NR}^{78}\text{R}^{79}$;
 20 $-(\text{CH}_2)_p\text{C}_6\text{H}_4\text{C}(=\text{NNR}^{78}\text{R}^{79})\text{NR}^{78}\text{R}^{79}$; $-(\text{CH}_2)_p\text{C}_6\text{H}_4\text{NR}^{80}\text{C}(=\text{NR}^{80})\text{NR}^{78}\text{R}^{79}$;
 $-(\text{CH}_2)_p\text{C}_6\text{H}_4\text{N}=\text{C}(\text{NR}^{78}\text{R}^{80})\text{NR}^{79}\text{R}^{80}$; $-(\text{CH}_2)_r\text{O}(\text{CH}_2)_m\text{NR}^{78}\text{R}^{79}$; $-(\text{CH}_2)_r\text{O}(\text{CH}_2)_m\text{NR}^{77}\text{R}^{80}$;
 $-(\text{CH}_2)_r\text{O}(\text{CH}_2)_p\text{C}(=\text{NR}^{80})\text{NR}^{78}\text{R}^{79}$; $-(\text{CH}_2)_r\text{O}(\text{CH}_2)_p\text{C}(=\text{NOR}^{50})\text{NR}^{78}\text{R}^{79}$;
 $-(\text{CH}_2)_r\text{O}(\text{CH}_2)_p\text{C}(=\text{NNR}^{78}\text{R}^{79})\text{NR}^{78}\text{R}^{79}$; $-(\text{CH}_2)_r\text{O}(\text{CH}_2)_m\text{NR}^{80}\text{C}(=\text{NR}^{80})\text{NR}^{78}\text{R}^{79}$;
 $-(\text{CH}_2)_r\text{O}(\text{CH}_2)_m\text{N}=\text{C}(\text{NR}^{78}\text{R}^{80})\text{NR}^{79}\text{R}^{80}$; $-(\text{CH}_2)_r\text{O}(\text{CH}_2)_p\text{C}_6\text{H}_4\text{CNR}^{78}\text{R}^{79}$;
 25 $-(\text{CH}_2)_r\text{O}(\text{CH}_2)_p\text{C}_6\text{H}_4\text{C}(=\text{NR}^{80})\text{NR}^{78}\text{R}^{79}$; $-(\text{CH}_2)_r\text{O}(\text{CH}_2)_p\text{C}_6\text{H}_4\text{C}(=\text{NOR}^{50})\text{NR}^{78}\text{R}^{79}$;
 $-(\text{CH}_2)_r\text{O}(\text{CH}_2)_p\text{C}_6\text{H}_4\text{C}(=\text{NNR}^{78}\text{R}^{79})\text{NR}^{78}\text{R}^{79}$;
 $-(\text{CH}_2)_r\text{O}(\text{CH}_2)_p\text{C}_6\text{H}_4\text{NR}^{80}\text{C}(=\text{NR}^{80})\text{NR}^{78}\text{R}^{79}$; $-(\text{CH}_2)_r\text{S}(\text{CH}_2)_m\text{NR}^{78}\text{R}^{79}$;
 $-(\text{CH}_2)_r\text{S}(\text{CH}_2)_m\text{NR}^{77}\text{R}^{80}$; $-(\text{CH}_2)_r\text{S}(\text{CH}_2)_p\text{C}(=\text{NR}^{80})\text{NR}^{78}\text{R}^{79}$;
 $-(\text{CH}_2)_r\text{S}(\text{CH}_2)_p\text{C}(=\text{NOR}^{50})\text{NR}^{78}\text{R}^{79}$; $-(\text{CH}_2)_r\text{S}(\text{CH}_2)_p\text{C}(=\text{NNR}^{78}\text{R}^{79})\text{NR}^{78}\text{R}^{79}$;
 30 $-(\text{CH}_2)_r\text{S}(\text{CH}_2)_m\text{NR}^{80}\text{C}(=\text{NR}^{80})\text{NR}^{78}\text{R}^{79}$; $-(\text{CH}_2)_r\text{S}(\text{CH}_2)_m\text{N}=\text{C}(\text{NR}^{78}\text{R}^{80})\text{NR}^{79}\text{R}^{80}$;
 $-(\text{CH}_2)_r\text{S}(\text{CH}_2)_p\text{C}_6\text{H}_4\text{CNR}^{78}\text{R}^{79}$; $-(\text{CH}_2)_r\text{S}(\text{CH}_2)_p\text{C}_6\text{H}_4\text{C}(=\text{NR}^{80})\text{NR}^{78}\text{R}^{79}$;
 $-(\text{CH}_2)_r\text{S}(\text{CH}_2)_p\text{C}_6\text{H}_4\text{C}(=\text{NOR}^{50})\text{NR}^{78}\text{R}^{79}$; $-(\text{CH}_2)_r\text{S}(\text{CH}_2)_p\text{C}_6\text{H}_4\text{C}(=\text{NNR}^{78}\text{R}^{79})\text{NR}^{78}\text{R}^{79}$;
 $-(\text{CH}_2)_r\text{S}(\text{CH}_2)_p\text{C}_6\text{H}_4\text{NR}^{80}\text{C}(=\text{NR}^{80})\text{NR}^{78}\text{R}^{79}$; $-(\text{CH}_2)_p\text{NR}^{80}\text{COR}^{64}$; $-(\text{CH}_2)_p\text{NR}^{80}\text{COR}^{77}$;
 $-(\text{CH}_2)_p\text{NR}^{80}\text{CONR}^{78}\text{R}^{79}$; or $-(\text{CH}_2)_p\text{C}_6\text{H}_4\text{NR}^{80}\text{CONR}^{78}\text{R}^{79}$;

R^{75} is lower alkyl; lower alkenyl; or aryl-lower alkyl;

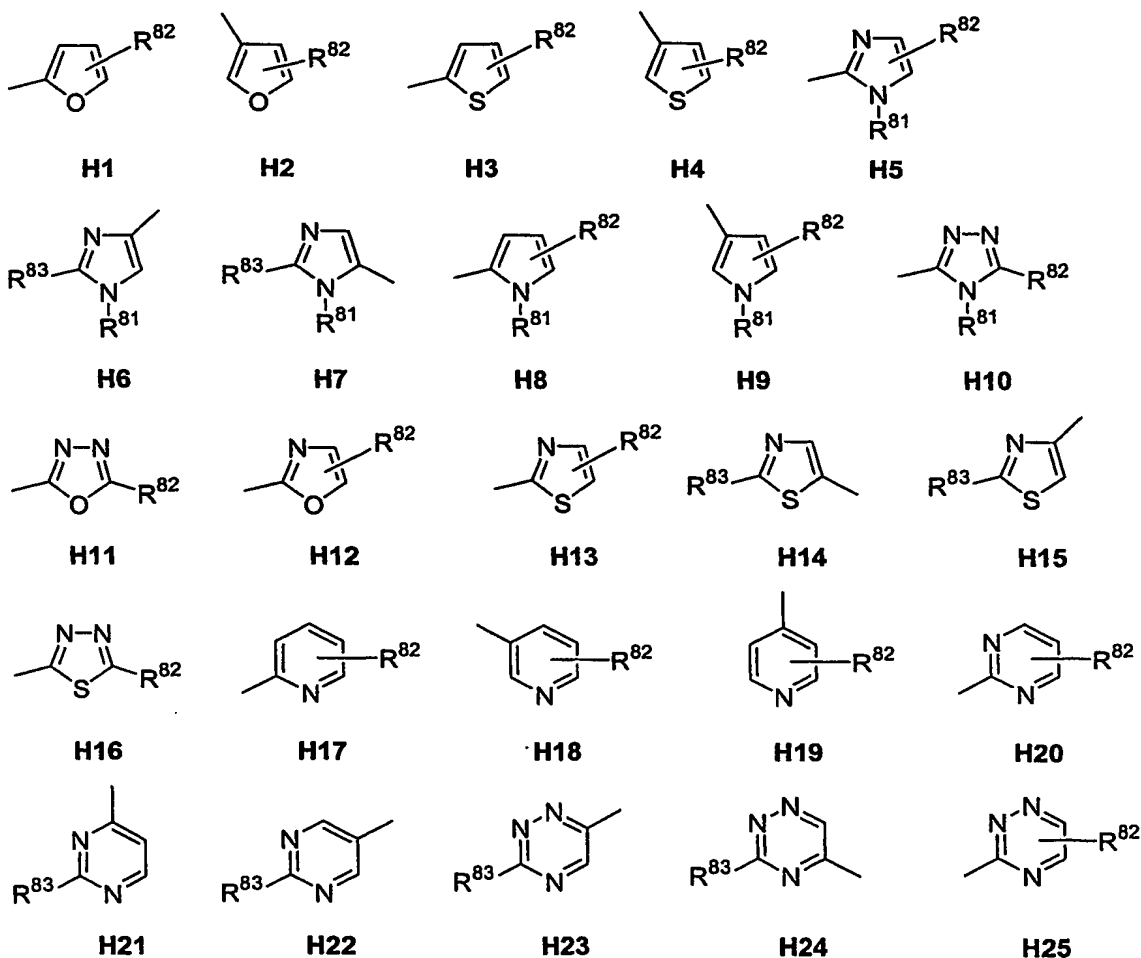
R^{33} and R^{75} taken together can form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$;

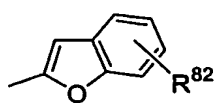
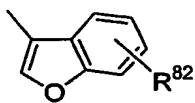
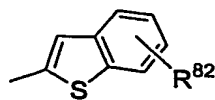
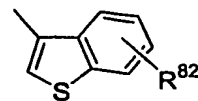
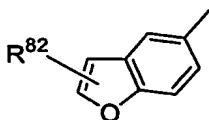
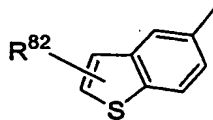
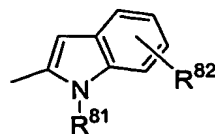
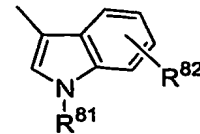
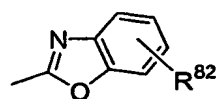
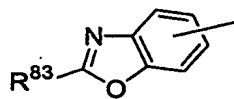
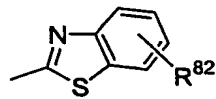
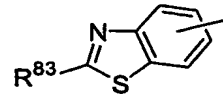
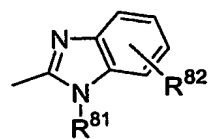
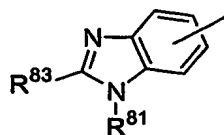
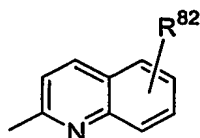
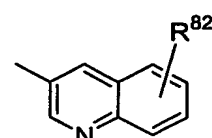
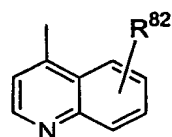
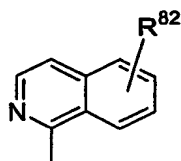
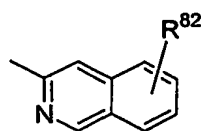
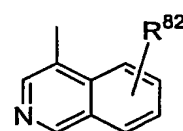
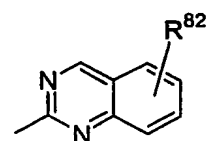
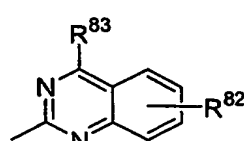
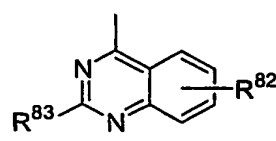
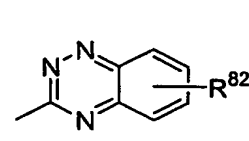
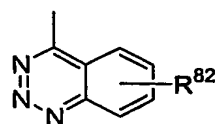
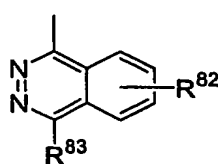
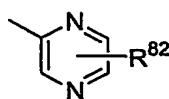
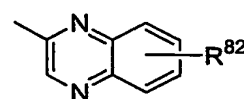
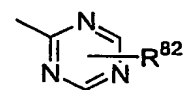
R^{75} and R^{82} taken together can form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$;

5

R^{76} is H; lower alkyl; lower alkenyl; aryl-lower alkyl; $-(CH_2)_oOR^{72}$; $-(CH_2)_oSR^{72}$; $-(CH_2)_oNR^{33}R^{34}$; $-(CH_2)_oOCONR^{33}R^{75}$; $-(CH_2)_oNR^{20}CONR^{33}R^{82}$; $-(CH_2)_oCOOR^{75}$; $-(CH_2)_oCONR^{58}R^{59}$; $-(CH_2)_oPO(OR^{60})_2$; $-(CH_2)_pSO_2R^{62}$; or $-(CH_2)_oCOR^{64}$;

10 R^{77} is $-C_6R^{67}R^{68}R^{69}R^{70}R^{76}$; or a heteroaryl group of one of the formulae



**H26****H27****H28****H29****H30****H31****H32****H33****H34****H35****H36****H37****H38****H39****H40****H41****H42****H43****H44****H45****H46****H47****H48****H49****H50****H51****H52****H53****H54**

- R^{78} is H; lower alkyl; aryl; or aryl-lower alkyl;
 R^{78} and R^{82} taken together can form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
 $-(CH_2)_2NR^{57}(CH_2)_2-$;
- 5 R^{79} is H; lower alkyl; aryl; or aryl-lower alkyl; or
 R^{78} and R^{79} , taken together, can be $-(CH_2)_{2-7}-$; $-(CH_2)_2O(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$;
 R^{80} is H; or lower alkyl;
 R^{81} is H; lower alkyl; or aryl-lower alkyl;
 R^{82} is H; lower alkyl; aryl; heteroaryl; or aryl-lower alkyl;
- 10 R^{33} and R^{82} taken together can form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
 $-(CH_2)_2NR^{57}(CH_2)_2-$;
 R^{83} is H; lower alkyl; aryl; or $-NR^{78}R^{79}$;
 R^{84} is $-(CH_2)_pCONR^{78}R^{79}$; $-(CH_2)_pNR^{80}CONR^{78}R^{79}$; $-(CH_2)_pC_6H_4CONR^{78}R^{79}$; or



R^{85} is lower alkyl; or lower alkenyl;

R^{86} is R^{74} ; $-[(\text{CH}_2)_u\text{-X}]_t\text{-(CH}_2)_v\text{NR}^{78}\text{R}^{79}$; $-[(\text{CH}_2)_u\text{-X}]_t\text{-(CH}_2)_v\text{-C(=NR}^{80})\text{NR}^{78}\text{R}^{79}$; X is $-\text{O}-$, $-\text{NR}^{20}-$, $-\text{S}-$, $\text{OCOO}-$, u is 1-3, t is 1-6, v is 1-3;

5

with the proviso that in said chains Z and Z' of n and , respectively, n' α -amino acid residues

- if n is 4 and n' is 6, the amino acid residues in positions 1 to 4 of Z and in positions 1' to 6' of Z' are:

10

- P1: of type C or of type D or of type E or of type F, or the residue is Pro;
- P2: of type E or of type F;
- P3: of type F, or the residue is Pro;
- P4: of type E;

15

- P1': of type C or of type D or of type E or of type F, or the residue is Gly;
- P2': of type D or of type C;
- P3': of type F or the residue is Pro;
- P4': of type D or of type C;

20

- P5': of type E, or of type F or the residue is Pro; and
- P6': of type E or of type F, or the residue is Pro; or

- P3 and P3', taken together, can form a group of type H;

25 and

- if n is 5 and n' is 7, the amino acid residues in positions 1 to 5 of Z and in positions 1' to 7' of Z' are:

30

- P1: of type C or of type D or of type E or of type F, or the residue is Pro;
- P2: of type E or of type F;
- P3: of type F, or the residue is Pro;
- P4: of type F;
- P5: of type E

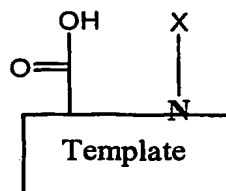
- P1': of type C or of type D or of type E or of type F, or the residue is Pro;
 - P2': of type F;
 - P3': of type D or the residue is Pro;
 - 5 - P4': of type E or of type F;
 - P5': of type D, or the residue is Pro;
 - P6': of type E or of type F, or the residue is Pro; and
 - P7': of type E or of type I, or the residue is Gly; or
- 10 - P2 and P2' and/or P4 and P4', taken together, can form a group of type H;
at P7' also D-isomers being possible,

and pharmaceutically acceptable salts thereof.

- 15 In accordance with the present invention these β -hairpin peptidomimetics can be prepared by a process which comprises

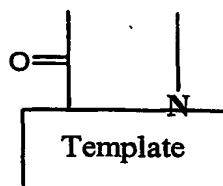
- (a) coupling an appropriately functionalized solid support with an appropriately N-protected derivative of that amino acid which in the desired end-product is in position 4 of Z if
20 n is 4 or in position 5 of Z if n is 5, any functional group which may be present in said N-protected amino acid derivative being likewise appropriately protected;
- (b) removing the N-protecting group from the product thus obtained;
- (c) coupling the product thus obtained with an appropriately N-protected derivative of that
25 amino acid which in Z of the desired end-product is one position nearer the N-terminal amino acid residue, any functional group which may be present in said N-protected amino acid derivative being likewise appropriately protected;
- (d) removing the N-protecting group from the product thus obtained;
- (e) repeating steps (c) and (d) until the N-terminal amino acid residue of Z has been introduced;
- 30 (f) coupling the product thus obtained with a compound of the general formula

24

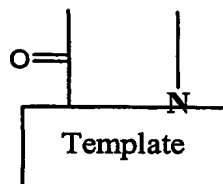


II

wherein



5 is as defined above and X is an N-protecting group or, if



is to be group (a1), or (a2), above, alternatively

10 (fa) coupling the product obtained in step (e) with an appropriately N-protected derivative of an amino acid of the general formula

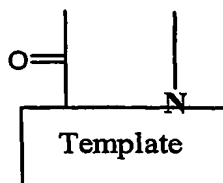


wherein B and A are as defined above, any functional group which may be present in said N-protected amino acid derivative being likewise appropriately protected;

15 (fb) removing the N-protecting group from the product thus obtained; and
 (fc) coupling the product thus obtained with an appropriately N-protected derivative of an amino acid of the above general formula IV and, respectively, III, any functional group which may be present in said N-protected amino acid derivative being likewise appropriately protected; or

20

if



- 5 is to be group (a3), above, alternatively
- (fa') coupling the product obtained in step (e) with an appropriately N-protected derivative of an amino acid of the above general formula III, any functional group which may be present in said N-protected amino acid derivative being likewise appropriately protected;
- 10 (fb') removing the N-protecting group from the product thus obtained; and
- (fc') coupling the product thus obtained with an appropriately N-protected derivative of an amino acid of the above general formula III, any functional group which may be present in said N-protected amino acid derivative being likewise appropriately protected;
- 15 (g) removing the N-protecting group from the product obtained in step (f) or (fc) or (fc');
- (h) coupling the product thus obtained with an appropriately N-protected derivative of that amino acid which in the desired end-product is in position 1 of Z^1 , any functional group which may be present in said N-protected amino acid derivative being likewise appropriately protected;
- 20 (i) removing the N-protecting group from the product thus obtained;
- (j) coupling the product thus obtained with an appropriately N-protected derivative of that amino acid which in the desired end-product is one position farther away from position 1 of Z^1 , any functional group which may be present in said N-protected amino acid derivative being likewise appropriately protected;
- 25 (k) removing the N-protecting group from the product thus obtained;
- (l) repeating steps (j) and (k) until all amino acid residues of Z^1 have been introduced;
- (m) if desired, selectively deprotecting one or several protected functional group(s) present in the molecule and appropriately substituting the reactive group(s) thus liberated;
- (n) if desired, forming one or two interstrand linkage(s) between side-chains of appropriate
- 30 amino acid residues at opposite positions of the β -strand region;

- (o) detaching the product thus obtained from the solid support and removing any protecting groups present on functional groups of any members of the chain of amino acid residues and, if desired, any protecting group(s) which may in addition be present in the molecule; and
- 5 (p) if desired, converting the product thus obtained into a pharmaceutically acceptable salt or converting a pharmaceutically acceptable, or unacceptable, salt thus obtained into the corresponding free compound of formula I or into a different, pharmaceutically acceptable, salt..
- 10 Introducing an amino acid residue of type I can, alternatively, be effected by coupling with a leaving group-containing acetylating agent, such as bromo, chloro or iodo acetic acid, followed by nucleophilic displacement with an amine of the formula H_2NR^{86} which, if necessary, is appropriately protected.
- 15 The peptidomimetics of the present invention can also be enantiomers of the compounds of formula I. These enantiomers can be prepared by a modification of the above process in which enantiomers of all chiral starting materials are used.
- As used in this description, the term "alkyl", taken alone or in combinations, designates
- 20 saturated, straight-chain or branched hydrocarbon radicals having up to 24, preferably up to 12, carbon atoms. Similarly, the term "alkenyl" designates straight chain or branched hydrocarbon radicals having up to 24, preferably up to 12, carbon atoms and containing at least one or, depending on the chain length, up to four olefinic double bonds. The term "lower" designates radicals and compounds having up to 6 carbon atoms. Thus, for example, the term "lower
- 25 alkyl" designates saturated, straight-chain or branched hydrocarbon radicals having up to 6 carbon atoms, such as methyl, ethyl, n-propyl, isopropyl, n-butyl, sec.-butyl, isobutyl, tert.-butyl and the like. The term "aryl" designates aromatic carbocyclic hydrocarbon radicals containing one or two six-membered rings, such as phenyl or naphthyl, which may be substituted by up to three substituents such as Br, Cl, F, CF_3 , NO_2 , lower alkyl or lower
- 30 alkenyl. The term "heteroaryl" designates aromatic heterocyclic radicals containing one or two five- and/or six-membered rings, at least one of them containing up to three heteroatoms selected from the group consisting of O, S and N and said ring(s) being optionally substituted; representative examples of such optionally substituted heteroaryl radicals are indicated hereinabove in connection with the definition of R^{77} .

The structural element **-A-CO-** designates amino acid building blocks which in combination with the structural element **-B-CO-** form templates **(a1)** and **(a2)**. The structural element **-B-CO-** forms either alone or in combination with another structural element **-B-CO-** templates **(a4)** and **(a3)**. Templates **(a)** through **(p)** constitute building blocks which have an N-terminus and a C-terminus oriented in space in such a way that the distance between those two groups may lie between 4.0-5.5Å. A peptide chain **Z** is linked to the C-terminus of the templates **(a)** through **(p)** via the N-terminus, and the corresponding N-terminus of the template is linked to the C-terminus of **Z¹** to form a β -hairpin structure such as that depicted in formula **I**. In a case as here where the distance between the N- and C- termini of the template lies between 4.0-5.5Å the template will induce the H-bond network necessary for the formation of a β -hairpin conformation within the peptide chain **Z** and **Z¹**. Thus template and peptide chains form a β -hairpin mimetic. The β -hairpin conformation is highly relevant for the CXCR4 antagonizing activity of the β -hairpin mimetics of the present invention.

Building blocks **A1-A69** belong to a class of amino acids wherein the N-terminus is a secondary amine forming part of a ring. Among the genetically encoded amino acids only proline falls into this class. The configuration of building block **A1** through **A69** is **(D)**, and they are combined with a building block **-B-CO-** of **(L)**-configuration. Preferred combinations for templates **(a1)** are **-^DA1-CO-^LB-CO-** to **-^DA69-CO-^LB-CO-**. Thus, for example, **^DPro-^LPro** constitutes the prototype of templates **(a1)**. Less preferred, but also possible are combinations where templates **(a2)** are **-^LA1-CO-^DB-CO-** to **-^LA69-CO-^DB-CO-**. Thus, for example, **^LPro-^DPro** constitutes a less preferred prototype of template **(a2)**.

It will be appreciated that building blocks **-A1-CO-** to **-A69-CO-** in which **A** has **(D)**-configuration, are carrying a group **R¹** at the α -position to the N-terminus. The preferred values for **R¹** are H and lower alkyl with the most preferred values for **R¹** being H and methyl. It will be recognized by those skilled in the art, that **A1-A69** are shown in **(D)**-configuration which, for **R¹** being H and methyl, corresponds to the **(R)**-configuration. Depending on the priority of other values for **R¹** according to the Cahn, Ingold and Prelog-rules, this configuration may also have to be expressed as **(S)**.

In addition to R¹ building blocks -A1-CO- to -A69-CO- can carry an additional substituent designated as R² to R¹⁷. This additional substituent can be H, and if it is other than H, it is preferably a small to medium-sized aliphatic or aromatic group. Examples of preferred values for R² to R¹⁷ are:

- 5 - R²: H; lower alkyl; lower alkenyl; (CH₂)_mOR⁵⁵ (where R⁵⁵: lower alkyl; or lower alkenyl); (CH₂)_mSR⁵⁶ (where R⁵⁶: lower alkyl; or lower alkenyl); (CH₂)_mNR³³R³⁴ (where R³³: lower alkyl; or lower alkenyl; R³⁴: H; or lower alkyl; R³³ and R³⁴ taken together form: -(CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; R⁵⁷: H; or lower alkyl); (CH₂)_mOCONR³³R⁷⁵ (where R³³: H; or lower alkyl; or lower alkenyl; R⁷⁵: lower alkyl; or R³³ and R⁷⁵ taken together form: -(CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_mNR²⁰CONR³³R⁸² (where R²⁰: H; or lower alkyl; R³³: H; or lower alkyl; or lower alkenyl; R⁸²: H; or lower alkyl; or R³³ and R⁸² taken together form: -(CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_oN(R²⁰)COR⁶⁴ (where: R²⁰: H; or lower alkyl; R⁶⁴: lower alkyl; or lower alkenyl); -(CH₂)_oCOOR⁵⁷ (where R⁵⁷: lower alkyl; or lower alkenyl); -(CH₂)_oCONR⁵⁸R⁵⁹ (where R⁵⁸: lower alkyl; or lower alkenyl; and R⁵⁹: H; or lower alkyl; or R⁵⁸ and R⁵⁹ taken together form: -(CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_oPO(OR⁶⁰)₂ (where R⁶⁰: lower alkyl; or lower alkenyl); -(CH₂)_oSO₂R⁶² (where R⁶²: lower alkyl; or lower alkenyl); or -(CH₂)_qC₆H₄R⁸ (where R⁸: H; F; Cl; CF₃; lower alkyl; lower alkenyl; or lower alkoxy).
- 15 - R³: H; lower alkyl; lower alkenyl; -(CH₂)_mOR⁵⁵ (where R⁵⁵: lower alkyl; or lower alkenyl); -(CH₂)_mSR⁵⁶ (where R⁵⁶: lower alkyl; or lower alkenyl); -(CH₂)_mNR³³R³⁴ (where R³³: lower alkyl; or lower alkenyl; R³⁴: H; or lower alkyl; or R³³ and R³⁴ taken together form: -(CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_mOCONR³³R⁷⁵ (where R³³: H; or lower alkyl; or lower alkenyl; R⁷⁵: lower alkyl; or R³³ and R⁷⁵ taken together form: -(CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_mNR²⁰CONR³³R⁸² (where R²⁰: H; or lower alkyl; R³³: H; or lower alkyl; or lower alkenyl; R⁸²: H; or lower alkyl; or R³³ and R⁸² taken together form: -(CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_oN(R²⁰)COR⁶⁴ (where: R²⁰: H; or lower alkyl; R⁶⁴: lower alkyl; or lower alkenyl); -(CH₂)_oCOOR⁵⁷ (where R⁵⁷: lower alkyl; or lower alkenyl); -(CH₂)_oCONR⁵⁸R⁵⁹ (where R⁵⁸: lower alkyl; or lower alkenyl; and R⁵⁹: H; or lower alkyl; or R⁵⁸ and R⁵⁹ taken together form: -(CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-;
- 25 (CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_oPO(OR⁶⁰)₂ (where R⁶⁰: lower alkyl; or lower alkenyl); -(CH₂)_oSO₂R⁶² (where R⁶²: lower alkyl; or lower alkenyl); or -(CH₂)_qC₆H₄R⁸ (where R⁸: H; F; Cl; CF₃; lower alkyl; lower alkenyl; or lower alkoxy).
- 30 (CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_oN(R²⁰)COR⁶⁴ (where: R²⁰: H; or lower alkyl; R⁶⁴: lower alkyl; or lower alkenyl); -(CH₂)_oCOOR⁵⁷ (where R⁵⁷: lower alkyl; or lower alkenyl); -(CH₂)_oCONR⁵⁸R⁵⁹ (where R⁵⁸: lower alkyl; or lower alkenyl; and R⁵⁹: H; or lower alkyl; or R⁵⁸ and R⁵⁹ taken together form: -(CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-;

- $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl; $(CH_2)_6PO(OR^{60})_2$
 (where R^{60} : lower alkyl; or lower alkenyl); $-(CH_2)_6SO_2R^{62}$ (where R^{62} : lower alkyl; or lower
 alkenyl); or $-(CH_2)_4C_6H_4R^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl; lower alkenyl; or lower
 alkoxy).
- 5 - R^4 : H; lower alkyl; lower alkenyl; $-(CH_2)_mOR^{55}$ (where R^{55} : lower alkyl; or lower
 alkenyl); $-(CH_2)_mSR^{56}$ (where R^{56} : lower alkyl; or lower alkenyl); $-(CH_2)_mNR^{33}R^{34}$ (where R^{33} :
 lower alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or R^{33} and R^{34} taken together form: -
 $(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower
 alkyl); $-(CH_2)_mOCONR^{33}R^{75}$ (where R^{33} : H; or lower alkyl; or lower alkenyl; R^{75} : lower alkyl;
 10 or R^{33} and R^{75} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
 $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_mNR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or
 lower alkyl; R^{33} : H; or lower alkyl; or lower alkenyl; R^{82} : H; or lower alkyl; or R^{33} and R^{82}
 taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
 $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_mN(R^{20})COR^{64}$ (where: R^{20} : H; or
 15 lower alkyl; R^{64} : lower alkyl; or lower alkenyl); $-(CH_2)_6COOR^{57}$ (where R^{57} : lower alkyl; or
 lower alkenyl); $-(CH_2)_6CONR^{58}R^{59}$ (where R^{58} : lower alkyl; or lower alkenyl; and R^{59} : H; or
 lower alkyl; or R^{58} and R^{59} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$;
 $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_6PO(OR^{60})_2$
 (where R^{60} : lower alkyl; or lower alkenyl); $-(CH_2)_6SO_2R^{62}$ (where R^{62} : lower alkyl; or lower
 20 alkenyl); or $-(CH_2)_4C_6H_4R^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl; lower alkenyl; or lower
 alkoxy).
- R^5 : lower alkyl; lower alkenyl; $-(CH_2)_6OR^{55}$ (where R^{55} : lower alkyl; or lower alkenyl);
 $-(CH_2)_6SR^{56}$ (where R^{56} : lower alkyl; or lower alkenyl); $-(CH_2)_6NR^{33}R^{34}$ (where R^{33} : lower
 alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or R^{33} and R^{34} taken together form:
 25 $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower
 alkyl); $-(CH_2)_6OCONR^{33}R^{75}$ (where R^{33} : H; or lower alkyl; or lower alkenyl; R^{75} : lower alkyl;
 or R^{33} and R^{75} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
 $-(CH_2)_2NR^{57}(CH_2)_2-$; R^{57} : where H; or lower alkyl); $(CH_2)_6NR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or
 lower alkyl; R^{33} : H; or lower alkyl; or lower alkenyl; R^{82} : H; or lower alkyl; or R^{33} and R^{82}
 30 taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
 $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $(CH_2)_6N(R^{20})COR^{64}$ (where: R^{20} : H; or
 lower alkyl; R^{64} : alkyl; alkenyl; aryl; and aryl-lower alkyl; heteroaryl-lower alkyl);
 $-(CH_2)_6COOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(CH_2)_6CONR^{58}R^{59}$ (where R^{58} :
 lower alkyl; or lower alkenyl; and R^{59} : H; or lower alkyl; or R^{58} and R^{59} taken together form: -

(CH₂)₂₋₆; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)₆PO(OR⁶⁰)₂ (where R⁶⁰: lower alkyl; or lower alkenyl); -(CH₂)₆SO₂R⁶² (where R⁶²: lower alkyl; or lower alkenyl); or -(CH₂)_qC₆H₄R⁸ (where R⁸: H; F; Cl; CF₃; lower alkyl; lower alkenyl; or lower alkoxy).

5 - R⁶: H; lower alkyl; lower alkenyl; -(CH₂)₆OR⁵⁵ (where R⁵⁵: lower alkyl; or lower alkenyl); -(CH₂)₆SR⁵⁶ (where R⁵⁶: lower alkyl; or lower alkenyl); -(CH₂)₆NR³³R³⁴ (where R³³: lower alkyl; or lower alkenyl; R³⁴: H; or lower alkyl; or R³³ and R³⁴ taken together form: -(CH₂)₂₋₆; -(CH₂)₂O(CH₂)₂; -(CH₂)₂S(CH₂)₂; or -(CH₂)₂NR⁵⁷(CH₂)₂; where R⁵⁷: H; or lower alkyl); -(CH₂)₆CONR³³R⁷⁵ (where R³³: H; or lower alkyl; or lower alkenyl; R⁷⁵: lower alkyl; or R³³ and R⁷⁵ taken together form: -(CH₂)₂₋₆; -(CH₂)₂O(CH₂)₂; -(CH₂)₂S(CH₂)₂; or -(CH₂)₂NR⁵⁷(CH₂)₂; where R⁵⁷: H; or lower alkyl); -(CH₂)₆NR²⁰CONR³³R⁸² (where R²⁰: H; or lower alkyl; R³³: H; or lower alkyl; or lower alkenyl; R⁸²: H; or lower alkyl; or R³³ and R⁸² taken together form: -(CH₂)₂₋₆; -(CH₂)₂O(CH₂)₂; -(CH₂)₂S(CH₂)₂; or -(CH₂)₂NR⁵⁷(CH₂)₂; where R⁵⁷: H; or lower alkyl); -(CH₂)₆N(R²⁰)COR⁶⁴ (where: R²⁰: H; or lower alkyl; R⁶⁴: lower alkyl; or lower alkenyl); -(CH₂)₆COOR⁵⁷ (where R⁵⁷: lower alkyl; or lower alkenyl); -(CH₂)₆CONR⁵⁸R⁵⁹ (where R⁵⁸: lower alkyl; or lower alkenyl; and R⁵⁹: H; or lower alkyl; or R⁵⁸ and R⁵⁹ taken together form: -(CH₂)₂₋₆; -(CH₂)₂O(CH₂)₂; -(CH₂)₂S(CH₂)₂; or -(CH₂)₂NR⁵⁷(CH₂)₂; where R⁵⁷: H; or lower alkyl); -(CH₂)₆PO(OR⁶⁰)₂ (where R⁶⁰: lower alkyl; or lower alkenyl); -(CH₂)₆SO₂R⁶² (where R⁶²: lower alkyl; or lower alkenyl); or -(CH₂)₄C₆H₄R⁸ (where R⁸: H; F; Cl; CF₃; lower alkyl; lower alkenyl; or lower alkoxy).

- R⁷: lower alkyl; lower alkenyl; -(CH₂)_qOR⁵⁵ (where R⁵⁵: lower alkyl; or lower alkenyl); -(CH₂)_qSR⁵⁶ (where R⁵⁶: lower alkyl; or lower alkenyl); -(CH₂)_qNR³³R³⁴ (where R³³: lower alkyl; or lower alkenyl; R³⁴: H; or lower alkyl; or R³³ and R³⁴ taken together form: -(CH₂)₂₋₆; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_qOCONR³³R⁷⁵ (where R³³: H; or lower alkyl; or lower alkenyl; R⁷⁵: lower alkyl; or R³³ and R⁷⁵ taken together form: -(CH₂)₂₋₆; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); (CH₂)_qNR²⁰CONR³³R⁸² (where R²⁰: H; or lower alkyl; R³³: H; or lower alkyl; or lower alkenyl; R⁸²: H; or lower alkyl; or R³³ and R⁸² taken together form: -(CH₂)₂₋₆; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_qN(R²⁰)COR⁶⁴ (where: R²⁰: H; or lower alkyl; R⁶⁴: lower alkyl; or lower alkenyl); -(CH₂)_qCOOR⁵⁷ (where R⁵⁷: lower alkyl; or lower alkenyl); -(CH₂)_qCONR⁵⁸R⁵⁹ (where R⁵⁸: lower alkyl; or lower alkenyl; and R⁵⁹: H; or lower alkyl; or R⁵⁸ and R⁵⁹ taken together form: -(CH₂)₂₋₆; -(CH₂)₂O(CH₂)₂-;

$-(\text{CH}_2)_2\text{S}(\text{CH}_2)_2-$; or $-(\text{CH}_2)_2\text{NR}^{57}(\text{CH}_2)_2-$; where R^{57} : H; or lower alkyl); $-(\text{CH}_2)_r\text{PO}(\text{OR}^{60})_2$ (where R^{60} : lower alkyl; or lower alkenyl); $(\text{CH}_2)_r\text{SO}_2\text{R}^{62}$ (where R^{62} : lower alkyl; or lower alkenyl); or $-(\text{CH}_2)_q\text{C}_6\text{H}_4\text{R}^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl; lower alkenyl; or lower alkoxy).

5 - R⁸: H; F; Cl; CF₃; lower alkyl; lower alkenyl; -(CH₂)₆OR⁵⁵ (where R⁵⁵: lower alkyl; or lower alkenyl); (CH₂)₆SR⁵⁶ (where R⁵⁶: lower alkyl; or lower alkenyl); -(CH₂)₆NR³³R³⁴ (where R³³: lower alkyl; or lower alkenyl; R³⁴: H; or lower alkyl; or R³³ and R³⁴ taken together form: - (CH₂)₂₋₆; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)₆OCONR³³R⁷⁵ (where R³³: H; or lower alkyl; or lower alkenyl; R⁷⁵: lower alkyl; or R³³ and R⁷⁵ taken together form: -(CH₂)₂₋₆; -(CH₂)₂O(CH₂)₂-;

$-(\text{CH}_2)_2\text{S}(\text{CH}_2)_2-$; or $-(\text{CH}_2)_2\text{NR}^{57}(\text{CH}_2)_2-$; where R^{57} : H; or lower alkyl);
 $-(\text{CH}_2)_6\text{NR}^{20}\text{CONR}^{33}\text{R}^{82}$ (where R^{20} : H; or lower alkyl; R^{33} : H; or lower alkyl; or lower alkenyl;
 R^{82} : H; or lower alkyl; or R^{33} and R^{82} taken together form: $-(\text{CH}_2)_{2-6}-$;
 $-(\text{CH}_2)_2\text{O}(\text{CH}_2)_2-$; $-(\text{CH}_2)_2\text{S}(\text{CH}_2)_2-$; or $-(\text{CH}_2)_2\text{NR}^{57}(\text{CH}_2)_2-$; where R^{57} : H; or lower alkyl);
 $-(\text{CH}_2)_6\text{N}(\text{R}^{20})\text{COR}^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl);
 $-(\text{CH}_2)_6\text{COOR}^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(\text{CH}_2)_6\text{CONR}^{58}\text{R}^{59}$ (where R^{58} :
lower alkyl; or lower alkenyl; and R^{59} : H; or lower alkyl; or R^{58} and R^{59} taken together form:
 $-(\text{CH}_2)_{2-6}-$; $-(\text{CH}_2)_2\text{O}(\text{CH}_2)_2-$; $-(\text{CH}_2)_2\text{S}(\text{CH}_2)_2-$; or $-(\text{CH}_2)_2\text{NR}^{57}(\text{CH}_2)_2-$; where R^{57} : H; or lower
alkyl); $-(\text{CH}_2)_6\text{PO}(\text{OR}^{60})_2$ (where R^{60} : lower alkyl; or lower alkenyl); $-(\text{CH}_2)_6\text{SO}_2\text{R}^{62}$ (where
 R^{62} : lower alkyl; or lower alkenyl); or $-(\text{CH}_2)_4\text{C}_6\text{H}_4\text{R}^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl;
lower alkenyl; or lower alkoxy).

- R⁹: lower alkyl; lower alkenyl; -(CH₂)₆OR⁵⁵ (where R⁵⁵: lower alkyl; or lower alkenyl); -(CH₂)₆SR⁵⁶ (where R⁵⁶: lower alkyl; or lower alkenyl); -(CH₂)₆NR³³R³⁴ (where R³³: lower alkyl; or lower alkenyl; R³⁴: H; or lower alkyl; or R³³ and R³⁴ taken together form: 25 -(CH₂)₂₋₆; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)₆OCONR³³R⁷⁵ (where R³³: H; or lower alkyl; or lower alkenyl; R⁷⁵: lower alkyl; or R³³ and R⁷⁵ taken together form: -(CH₂)₂₋₆; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_mNR²⁰CONR³³R⁸² (where R²⁰: H; or lower alkyl; R³³: H; or lower alkyl; or lower alkenyl; R⁸²: H; or lower alkyl; or R³³ and R⁸² 30 taken together form: -(CH₂)₂₋₆; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)₆N(R²⁰)COR⁶⁴ (where: R²⁰: H; or lower alkyl; R⁶⁴: lower alkyl; or lower alkenyl); -(CH₂)₆COOR⁵⁷ (where R⁵⁷: lower alkyl; or lower alkenyl); -(CH₂)₆CONR⁵⁸R⁵⁹ (where R⁵⁸: lower alkyl; or lower alkenyl; and R⁵⁹: H; or lower alkyl; or R⁵⁸ and R⁵⁹ taken together form: -(CH₂)₂₋₆; -(CH₂)₂O(CH₂)₂-;

$-(\text{CH}_2)_2\text{S}(\text{CH}_2)_2-$; or $-(\text{CH}_2)_2\text{NR}^{57}(\text{CH}_2)_2-$; where R^{57} : H; or lower alkyl; $-(\text{CH}_2)_o\text{PO}(\text{OR}^{60})_2$ (where R^{60} : lower alkyl; or lower alkenyl); $-(\text{CH}_2)_o\text{SO}_2\text{R}^{62}$ (where R^{62} : lower alkyl; or lower alkenyl); or $-(\text{CH}_2)_q\text{C}_6\text{H}_4\text{R}^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl; lower alkenyl; or lower alkoxy).

5 - R¹⁰: lower alkyl; lower alkenyl; -(CH₂)₆OR⁵⁵ (where R⁵⁵: lower alkyl; or lower alkenyl); -(CH₂)₆SR⁵⁶ (where R⁵⁶: lower alkyl; or lower alkenyl); -(CH₂)₆NR³³R³⁴ (where R³³: lower alkyl; or lower alkenyl; R³⁴: H; or lower alkyl; or R³³ and R³⁴ taken together form: -(CH₂)₂₋₆; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)₆OCONR³³R⁷⁵ (where R³³: H; or lower alkyl; or lower alkenyl; R⁷⁵: lower alkyl; or R³³ and R⁷⁵ taken together form: -(CH₂)₂₋₆; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)₆NR²⁰CONR³³R⁸² (where R²⁰: H; or lower alkyl; R³³: H; or lower alkyl; or lower alkenyl; R⁸²: H; or lower alkyl; or R³³ and R⁸² taken together form: -(CH₂)₂₋₆; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)₆N(R²⁰)COR⁶⁴ (where: R²⁰: H; or lower alkyl; R⁶⁴: lower alkyl; or lower alkenyl); -(CH₂)₆COOR⁵⁷ (where R⁵⁷: lower alkyl; or lower alkenyl); -(CH₂)₆CONR⁵⁸R⁵⁹ (where R⁵⁸: lower alkyl; or lower alkenyl; and R⁵⁹: H; lower alkyl; or R⁵⁸ and R⁵⁹ taken together form: -(CH₂)₂₋₆; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)₆PO(OR⁶⁰)₂ (where R⁶⁰: lower alkyl; or lower alkenyl); -(CH₂)₆SO₂R⁶² (where R⁶²: lower alkyl; or lower alkenyl); or -(CH₂)₄C₆H₄R⁸ (where R⁸: H; F; Cl; CF₃; lower alkyl; lower alkenyl; or lower alkoxy).

- R¹¹: H; lower alkyl; lower alkenyl; -(CH₂)_mOR⁵⁵ (where R⁵⁵: lower alkyl; or lower alkenyl); -(CH₂)_mSR⁵⁶ (where R⁵⁶: lower alkyl; or lower alkenyl); -(CH₂)_mNR³³R³⁴ (where R³³: lower alkyl; or lower alkenyl; R³⁴: H; or lower alkyl; or R³³ and R³⁴ taken together form: - (CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_mCONR³³R⁷⁵ (where R³³: H; or lower alkyl; or lower alkenyl; R⁷⁵: lower alkyl; or R³³ and R⁷⁵ taken together form: -(CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_mNR²⁰CONR³³R⁸² (where R²⁰: H; or lower alkyl; R³³: H; or lower alkyl; or lower alkenyl; R⁸²: H; or lower alkyl; or R³³ and R⁸² taken together form: -(CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_mN(R²⁰)COR⁶⁴ (where: R²⁰: H; or lower alkyl; R⁶⁴: lower alkyl; or lower alkenyl); -(CH₂)_oCOOR⁵⁷ (where R⁵⁷: lower alkyl; or lower alkenyl); -(CH₂)_oCONR⁵⁸R⁵⁹ (where R⁵⁸: lower alkyl; or lower alkenyl; and R⁵⁹: H; lower alkyl; or R⁵⁸ and R⁵⁹ taken together form: -(CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-;

$-(\text{CH}_2)_2\text{S}(\text{CH}_2)_2-$; or $-(\text{CH}_2)_2\text{NR}^{57}(\text{CH}_2)_2-$; where R^{57} : H; or lower alkyl; $-(\text{CH}_2)_6\text{PO}(\text{OR}^{60})_2$ (where R^{60} : lower alkyl; or lower alkenyl); $-(\text{CH}_2)_6\text{SO}_2\text{R}^{62}$ (where R^{62} : lower alkyl; or lower alkenyl); or $-(\text{CH}_2)_q\text{C}_6\text{H}_4\text{R}^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl; lower alkenyl; or lower alkoxy).

5 - R¹²: H; lower alkyl; lower alkenyl; -(CH₂)_mOR⁵⁵ (where R⁵⁵: lower alkyl; or lower alkenyl); -(CH₂)_mSR⁵⁶ (where R⁵⁶: lower alkyl; or lower alkenyl); -(CH₂)_mNR³³R³⁴ (where R³³: lower alkyl; or lower alkenyl; R³⁴: H; or lower alkyl; or R³³ and R³⁴ taken together form: - (CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_mOCONR³³R⁷⁵ (where R³³: H; or lower alkyl; or lower alkenyl; R⁷⁵: lower alkyl; or R³³ and R⁷⁵ taken together form: -(CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_mNR²⁰CONR³³R⁸² (where R²⁰: H; or lower alkyl; R³³: H; or lower alkyl; or lower alkenyl; R⁸²: H; or lower alkyl; or R³³ and R⁸² taken together form: -(CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_mN(R²⁰)COR⁶⁴ (where: R²⁰: H; or lower alkyl; R⁶⁴: lower alkyl; or lower alkenyl); -(CH₂)_rCOOR⁵⁷ (where R⁵⁷: lower alkyl; or lower alkenyl); -(CH₂)_rCONR⁵⁸R⁵⁹ (where R⁵⁸: lower alkyl; or lower alkenyl; and R⁵⁹: H; or lower alkyl; or R⁵⁸ and R⁵⁹ taken together form: -(CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_rPO(OR⁶⁰)₂ (where R⁶⁰: lower alkyl; or lower alkenyl); -(CH₂)₆SO₂R⁶² (where R⁶²: lower alkyl; or lower alkenyl); or -(CH₂)_qC₆H₄R⁸ (where R⁸: H; F; Cl; CF₃; lower alkyl; lower alkenyl; or lower alkoxy).

- R¹³: lower alkyl; lower alkenyl; -(CH₂)_qOR⁵⁵ (where R⁵⁵: lower alkyl; or lower alkenyl); -(CH₂)_qSR⁵⁶ (where R⁵⁶: lower alkyl; or lower alkenyl); -(CH₂)_qNR³³R³⁴ (where R³³: lower alkyl; or lower alkenyl; R³⁴: H; or lower alkyl; or R³³ and R³⁴ taken together form: 25 -(CH₂)₂₋₆; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_qOCONR³³R⁷⁵ (where R³³: H; or lower alkyl; or lower alkenyl; R⁷⁵: lower alkyl; or R³³ and R⁷⁵ taken together form: -(CH₂)₂₋₆; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or 30 -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_qNR²⁰CONR³³R⁸² (where R²⁰: H; or lower alkyl; R³³: H; or lower alkyl; or lower alkenyl; R⁸²: H; or lower alkyl; or R³³ and R⁸² taken together form: -(CH₂)₂₋₆; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or 35 -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_qN(R²⁰)COR⁶⁴ (where: R²⁰: H; or lower alkyl; R⁶⁴: lower alkyl; or lower alkenyl); -(CH₂)_qCOO⁵⁷ (where R⁵⁷: lower alkyl; or lower alkenyl); -(CH₂)_qCONR⁵⁸R⁵⁹ (where R⁵⁸: lower alkyl; or lower alkenyl; and R⁵⁹: H; or lower alkyl; or R⁵⁸ and R⁵⁹ taken together form: -(CH₂)₂₋₆; -(CH₂)₂O(CH₂)₂-;

- $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl; $-(CH_2)_rPO(OR^{60})_2$ (where R^{60} : lower alkyl; or lower alkenyl); $-(CH_2)_rSO_2R^{62}$ (where R^{62} : lower alkyl; or lower alkenyl); or
 $-(CH_2)_qC_6H_4R^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl; lower alkenyl; or lower alkoxy).
- 5 - R^{14} : H; lower alkyl; lower alkenyl; $-(CH_2)_mOR^{55}$ (where R^{55} : lower alkyl; or lower alkenyl); $-(CH_2)_mSR^{56}$ (where R^{56} : lower alkyl; or lower alkenyl); $-(CH_2)_mNR^{33}R^{34}$ (where R^{33} : lower alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or R^{33} and R^{34} taken together form: -
 $(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_mOCONR^{33}R^{75}$ (where R^{33} : H; or lower alkyl; or lower alkenyl; R^{75} : lower alkyl; or R^{33} and R^{75} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
 10 $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_mNR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or lower alkyl; R^{33} : H; or lower alkyl; or lower alkenyl; R^{82} : H; or lower alkyl; or R^{33} and R^{82} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
 $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_mN(R^{20})COR^{64}$ (where: R^{20} : H; lower alkyl; R^{64} : lower alkyl; or lower alkenyl); $-(CH_2)_oCOOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(CH_2)_oCONR^{58}R^{59}$ (where R^{58} : lower alkyl; or lower alkenyl; and R^{59} : H; or lower alkyl; or R^{58} and R^{59} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$;
 $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_oPO(OR^{60})_2$ (where R^{60} : lower alkyl; or lower alkenyl); $-(CH_2)_oSO_2R^{62}$ (where R^{62} : lower alkyl; or lower alkenyl); $-(CH_2)_qC_6H_4R^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl; lower alkenyl; or lower alkoxy).
- 15 - R^{15} : lower alkyl; lower alkenyl; $-(CH_2)_oOR^{55}$ (where R^{55} : lower alkyl; or lower alkenyl); $-(CH_2)_oSR^{56}$ (where R^{56} : lower alkyl; or lower alkenyl); $-(CH_2)_oNR^{33}R^{34}$ (where R^{33} : lower alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or R^{33} and R^{34} taken together form:
- 20 $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_oOCONR^{33}R^{75}$ (where R^{33} : H; or lower alkyl; or lower alkenyl; R^{75} : lower alkyl; or R^{33} and R^{75} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
 $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_oNR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or lower alkyl; R^{33} : H; or lower alkyl; or lower alkenyl; R^{82} : H; or lower alkyl; or R^{33} and R^{82} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
 25 $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_oN(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl); particularly favoured are $NR^{20}CO$ lower alkyl ($R^{20}=H$; or lower alkyl); $-(CH_2)_oCOOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl);
 $-(CH_2)_oCONR^{58}R^{59}$ (where R^{58} : lower alkyl, or lower alkenyl; and R^{59} : H; lower alkyl; or R^{58}
- 30 - R^{15} : lower alkyl; lower alkenyl; $-(CH_2)_oOR^{55}$ (where R^{55} : lower alkyl; or lower alkenyl); $-(CH_2)_oSR^{56}$ (where R^{56} : lower alkyl; or lower alkenyl); $-(CH_2)_oNR^{33}R^{34}$ (where R^{33} : lower alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or R^{33} and R^{34} taken together form:
- 25 $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_oOCONR^{33}R^{75}$ (where R^{33} : H; or lower alkyl; or lower alkenyl; R^{75} : lower alkyl; or R^{33} and R^{75} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
 $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_oNR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or lower alkyl; R^{33} : H; or lower alkyl; or lower alkenyl; R^{82} : H; or lower alkyl; or R^{33} and R^{82} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
 30 $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_oN(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl); particularly favoured are $NR^{20}CO$ lower alkyl ($R^{20}=H$; or lower alkyl); $-(CH_2)_oCOOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl);
 $-(CH_2)_oCONR^{58}R^{59}$ (where R^{58} : lower alkyl, or lower alkenyl; and R^{59} : H; lower alkyl; or R^{58}

and R⁵⁹ taken together form: -(CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl; -(CH₂)₆PO(OR⁶⁰)₂ (where R⁶⁰: lower alkyl; or lower alkenyl); -(CH₂)₆SO₂R⁶² (where R⁶²: lower alkyl; or lower alkenyl); or -(CH₂)₆C₆H₄R⁸ (where R⁸: H; F; Cl; CF₃; lower alkyl; lower alkenyl; or lower alkoxy).

5 - R¹⁶: lower alkyl; lower alkenyl; -(CH₂)_oOR⁵⁵ (where R⁵⁵: lower alkyl; or lower alkenyl); -(CH₂)_oSR⁵⁶ (where R⁵⁶: lower alkyl; or lower alkenyl); -(CH₂)_oNR³³R³⁴ (where R³³: lower alkyl; or lower alkenyl; R³⁴: H; or lower alkyl; or R³³ and R³⁴ taken together form: -(CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_oCONR³³R⁷⁵ (where R³³: H; or lower alkyl; or lower alkenyl; R⁷⁵: lower alkyl; or R³³ and R⁷⁵ taken together form: -(CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_oNR²⁰CONR³³R⁸² (where R²⁰: H; or lower alkyl; R³³: H; or lower alkyl; or lower alkenyl; R⁸²: H; or lower alkyl; or R³³ and R⁸² taken together form: -(CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_oN(R²⁰)COR⁶⁴ (where: R²⁰: H; or lower alkyl; R⁶⁴: lower alkyl; or lower alkenyl); -(CH₂)_oCOOR⁵⁷ (where R⁵⁷: lower alkyl; or lower alkenyl); -(CH₂)_oCONR⁵⁸R⁵⁹ (where R⁵⁸: lower alkyl; or lower alkenyl; and R⁵⁹: H; or lower alkyl; or R⁵⁸ and R⁵⁹ taken together form: -(CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_oPO(OR⁶⁰)₂ (where R⁶⁰: lower alkyl; or lower alkenyl); -(CH₂)_oSO₂R⁶² (where R⁶²: lower alkyl; or lower alkenyl); or -(CH₂)_qC₆H₄R⁸ (where R⁸: H; F; Cl; CF₃; lower alkyl; lower alkenyl; or lower alkoxy).

15 - R¹⁷: lower alkyl; lower alkenyl; -(CH₂)_qOR⁵⁵ (where R⁵⁵: lower alkyl; or lower alkenyl); -(CH₂)_qSR⁵⁶ (where R⁵⁶: lower alkyl; or lower alkenyl); -(CH₂)_qNR³³R³⁴ (where R³³: lower alkyl; or lower alkenyl; R³⁴: H; or lower alkyl; or R³³ and R³⁴ taken together form: -(CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_qOCONR³³R⁷⁵ (where R³³: H; or lower alkyl; or lower alkenyl; R⁷⁵: lower alkyl; or R³³ and R⁷⁵ taken together form: -(CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_qNR²⁰CONR³³R⁸² (where R²⁰: H; or lower alkyl; R³³: H; or lower alkyl; or lower alkenyl; R⁸²: H; or lower alkyl; or R³³ and R⁸² taken together form: -(CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-; -(CH₂)₂S(CH₂)₂-; or -(CH₂)₂NR⁵⁷(CH₂)₂-; where R⁵⁷: H; or lower alkyl); -(CH₂)_qN(R²⁰)COR⁶⁴ (where: R²⁰: H; or lower alkyl; R⁶⁴: lower alkyl; or lower alkenyl); -(CH₂)_qCOOR⁵⁷ (where R⁵⁷: lower alkyl; or lower alkenyl); -(CH₂)_qCONR⁵⁸R⁵⁹ (where R⁵⁸: lower alkyl; or lower alkenyl; and R⁵⁹: H; or lower alkyl; or R⁵⁸ and R⁵⁹ taken together form: -(CH₂)₂₋₆-; -(CH₂)₂O(CH₂)₂-;

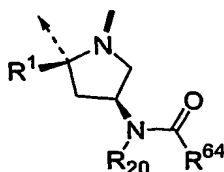
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$-(\text{CH}_2)_2\text{S}(\text{CH}_2)_2-$; or $-(\text{CH}_2)_2\text{NR}^{57}(\text{CH}_2)_2-$; where R^{57} : H; or lower alkyl); $-(\text{CH}_2)_t\text{PO}(\text{OR}^{60})_2$ (where R^{60} : lower alkyl; or lower alkenyl); $-(\text{CH}_2)_r\text{SO}_2\text{R}^{62}$ (where R^{62} : lower alkyl; or lower alkenyl); or $-(\text{CH}_2)_q\text{C}_6\text{H}_4\text{R}^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl; lower alkenyl; or lower alkoxy).

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Among the building blocks A1 to A69 the following are preferred: A5 with R^2 being H, A8, A22, A25, A38 with R^2 being H, A42, A47, and A50. Most preferred are building blocks of type A8':



A8'

- 10 wherein R^{20} is H or lower alkyl; and R^{64} is alkyl; alkenyl; aryl; aryl-lower alkyl; or heteroaryl-lower alkyl; especially those wherein R^{64} is n-hexyl (A8'-1); n-heptyl (A8'-2); 4-(phenyl)benzyl (A8'-3); diphenylmethyl (A8'-4); 3-amino-propyl (A8'-5); 5-amino-pentyl (A8'-6); methyl (A8'-7); ethyl (A8'-8); isopropyl (A8'-9); isobutyl (A8'-10); n-propyl (A8'-11); cyclohexyl (A8'-12); cyclohexylmethyl (A8'-13); n-butyl (A8'-14); phenyl (A8'-15);
15 benzyl (A8'-16); (3-indolyl)methyl (A8'-17); 2-(3-indolyl)ethyl (A8'-18); (4-phenyl)phenyl (A8'-19); and n-nonyl (A8'-20).

- Building block A70 belongs to the class of open-chain α -substituted α -amino acids, building blocks A71 and A72 to the corresponding β -amino acid analogues and building blocks A73-
20 A104 to the cyclic analogues of A70. Such amino acid derivatives have been shown to constrain small peptides in well defined reverse turn or U-shaped conformations (C. M. Venkatachalam, Biopolymers, 1968, 6, 1425-1434; W. Kabsch, C Sander, Biopolymers 1983, 22, 2577). Such building blocks or templates are ideally suited for the stabilization of β -hairpin conformations in peptide loops (D. Obrecht, M. Altorfer, J. A. Robinson, "Novel Peptide
25 Mimetic Building Blocks and Strategies for Efficient Lead Finding", Adv. Med Chem. 1999, Vol.4, 1-68; P. Balaram, "Non-standard amino acids in peptide design and protein engineering", Curr. Opin. Struct. Biol. 1992, 2, 845-851; M. Crisma, G. Valle, C. Toniolo, S. Prasad, R. B. Rao, P. Balaram, " β -turn conformations in crystal structures of model peptides

containing α,α - disubstituted amino acids", Biopolymers **1995**, 35, 1-9; V. J. Hruby, F. Al-Obeidi, W. Kazmierski, Biochem. J. **1990**, 268, 249-262).

It has been shown that both enantiomers of building blocks -A70-CO- to A104-CO- in
 5 combination with a building block -B-CO- of L-configuration can efficiently stabilize and induce β -hairpin conformations (D. Obrecht, M. Altorfer, J. A. Robinson, "Novel Peptide Mimetic Building Blocks and Strategies for Efficient Lead Finding", Adv. Med Chem. **1999**, Vol.4, 1-68; D. Obrecht, C. Spiegler, P. Schönholzer, K. Müller, H. Heimgartner, F. Stierli, Helv. Chim. Acta **1992**, 75, 1666-1696; D. Obrecht, U. Bohdal, J. Daly, C. Lehmann, P.
 10 Schönholzer, K. Müller, Tetrahedron **1995**, 51, 10883-10900; D. Obrecht, C. Lehmann, C. Ruffieux, P. Schönholzer, K. Müller, Helv. Chim. Acta **1995**, 78, 1567-1587; D. Obrecht, U. Bohdal, C. Broger, D. Bur, C. Lehmann, R. Ruffieux, P. Schönholzer, C. Spiegler, Helv. Chim. Acta **1995**, 78, 563-580; D. Obrecht, H. Karajiannis, C. Lehmann, P. Schönholzer, C. Spiegler, Helv. Chim. Acta **1995**, 78, 703-714).

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Thus, for the purposes of the present invention templates (a1) can also consist of -A70-CO- to A104-CO- where building block A70 to A104 is of either (D)- or (L)-configuration, in combination with a building block -B-CO- of (L)- configuration.

20 Preferred values for R^{20} in A70 to A104 are H or lower alkyl with methyl being most preferred. Preferred values for R^{18} , R^{19} and R^{21} - R^{29} in building blocks A70 to A104 are the following:

- R^{18} : lower alkyl.
- R^{19} : lower alkyl; lower alkenyl; $-(CH_2)_pOR^{55}$ (where R^{55} : lower alkyl; or lower alkenyl); $-(CH_2)_pSR^{56}$ (where R^{56} : lower alkyl; or lower alkenyl); $-(CH_2)_pNR^{33}R^{34}$ (where R^{33} :
 25 lower alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or R^{33} and R^{34} taken together form: $-(CH_2)_2$ -; $-(CH_2)_2O(CH_2)_2$ -; $-(CH_2)_2S(CH_2)_2$ -; or $-(CH_2)_2NR^{57}(CH_2)_2$ -; where R^{57} : H; or lower alkyl); $-(CH_2)_pOCONR^{33}R^{75}$ (where R^{33} : H; or lower alkyl; or lower alkenyl; R^{75} : lower alkyl; or R^{33} and R^{75} taken together form: $-(CH_2)_2$ -; $-(CH_2)_2O(CH_2)_2$ -; $-(CH_2)_2S(CH_2)_2$ -; or
 30 $-(CH_2)_2NR^{57}(CH_2)_2$ -; where R^{57} : H; or lower alkyl); $-(CH_2)_pNR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or lower alkyl; R^{33} : H; or lower alkyl; or lower alkenyl; R^{82} : H; or lower alkyl; or R^{33} and R^{82} taken together form: $-(CH_2)_2$ -; $-(CH_2)_2O(CH_2)_2$ -; $-(CH_2)_2S(CH_2)_2$ -; or
 $-(CH_2)_2NR^{57}(CH_2)_2$ -; where R^{57} : H; or lower alkyl); $-(CH_2)_pN(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl); $-(CH_2)_pCOOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(CH_2)_pCONR^{58}R^{59}$ (where R^{58} : lower alkyl; or lower alkenyl; and R^{59} : H; or

lower alkyl; or R⁵⁸ and R⁵⁹ taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R⁵⁷: H; or lower alkyl); $-(CH_2)_6PO(OR^{60})_2$ (where R⁶⁰: lower alkyl; or lower alkenyl); $-(CH_2)_pSO_2R^{62}$ (where R⁶²: lower alkyl; or lower alkenyl); or $-(CH_2)_6C_6H_4R^8$ (where R⁸: H; F; Cl; CF₃; lower alkyl; lower alkenyl; or lower alkoxy).

- R²¹: H; lower alkyl; lower alkenyl; $-(CH_2)_6OR^{55}$ (where R⁵⁵: lower alkyl; or lower alkenyl); $-(CH_2)_6SR^{56}$ (where R⁵⁶: lower alkyl; or lower alkenyl); $-(CH_2)_6NR^{33}R^{34}$ (where R³³: lower alkyl; or lower alkenyl; R³⁴: H; or lower alkyl; or R³³ and R³⁴ taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R⁵⁷: H; or lower alkyl); $-(CH_2)_6OCONR^{33}R^{75}$ (where R³³: H; or lower alkyl; or lower alkenyl; R⁷⁵: lower alkyl; or R³³ and R⁷⁵ taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R⁵⁷: H; or lower alkyl); $-(CH_2)_6NR^{20}CONR^{33}R^{82}$ (where R²⁰: H; or lower alkyl; R³³: H; or lower alkyl; or lower alkenyl; R⁸²: H; or lower alkyl; or R³³ and R⁸² taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R⁵⁷: H; or lower alkyl); $-(CH_2)_6N(R^{20})COR^{64}$ (where: R²⁰: H; or lower alkyl; R⁶⁴: lower alkyl; or lower alkenyl); $-(CH_2)_6COOR^{57}$ (where R⁵⁷: lower alkyl; or lower alkenyl); $-(CH_2)_6CONR^{58}R^{59}$ (where R⁵⁸: lower alkyl, or lower alkenyl; and R⁵⁹: H; lower alkyl; or R⁵⁸ and R⁵⁹ taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R⁵⁷: H; or lower alkyl); $-(CH_2)_6PO(OR^{60})_2$ (where R⁶⁰: lower alkyl; or lower alkenyl); $(CH_2)_6SO_2R^{62}$ (where R⁶²: lower alkyl; or lower alkenyl); or $(CH_2)_6C_6H_4R^8$ (where R⁸: H; F; Cl; CF₃; lower alkyl; lower alkenyl; or lower alkoxy).

- R²²: lower alkyl; lower alkenyl; $-(CH_2)_6OR^{55}$ (where R⁵⁵: lower alkyl; or lower alkenyl); $-(CH_2)_6SR^{56}$ (where R⁵⁶: lower alkyl; or lower alkenyl); $-(CH_2)_6NR^{33}R^{34}$ (where R³³: lower alkyl; or lower alkenyl; R³⁴: H; or lower alkyl; or R³³ and R³⁴ taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R⁵⁷: H; or lower alkyl); $-(CH_2)_6OCONR^{33}R^{75}$ (where R³³: H; or lower alkyl; or lower alkenyl; R⁷⁵: lower alkyl; or R³³ and R⁷⁵ taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R⁵⁷: H; or lower alkyl); $-(CH_2)_6NR^{20}CONR^{33}R^{82}$ (where R²⁰: H; or lower alkyl; R³³: H; or lower alkyl; or lower alkenyl; R⁸²: H; or lower alkyl; or R³³ and R⁸² taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R⁵⁷: H; or lower alkyl); $-(CH_2)_6N(R^{20})COR^{64}$ (where: R²⁰: H; or lower alkyl; R⁶⁴: lower alkyl; or lower alkenyl); $-(CH_2)_6COOR^{57}$ (where R⁵⁷: lower alkyl; or lower alkenyl); $-(CH_2)_6CONR^{58}R^{59}$ (where R⁵⁸: lower alkyl, or lower alkenyl; and R⁵⁹: H; lower

- alkyl; or R^{58} and R^{59} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl; $-(CH_2)_6PO(OR^{60})_2$ (where R^{60} : lower alkyl; or lower alkenyl); $-(CH_2)_6SO_2R^{62}$ (where R^{62} : lower alkyl; or lower alkenyl); or $-(CH_2)_qC_6H_4R^8$ (where R^8 : H; F; Cl; CF₃; lower alkyl; lower alkenyl; or lower alkoxy).
- 5 - R^{23} : H; lower alkyl; lower alkenyl; $-(CH_2)_6OR^{55}$ (where R^{55} : lower alkyl; or lower alkenyl); $-(CH_2)_6SR^{56}$ (where R^{56} : lower alkyl; or lower alkenyl); $-(CH_2)_6NR^{33}R^{34}$ (where R^{33} : lower alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or R^{33} and R^{34} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_6OCONR^{33}R^{75}$ (where R^{33} : H; or lower alkyl; or lower alkenyl; R^{75} : lower alkyl; or R^{33} and R^{75} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_6NR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or lower alkyl; R^{33} : H; or lower alkyl; or lower alkenyl; R^{82} : H; or lower alkyl; or R^{33} and R^{82} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
- 10 $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_6N(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl); particularly favoured are $NR^{20}CO$ lower alkyl ($R^{20}=H$; or lower alkyl); $-(CH_2)_6COOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(CH_2)_6CONR^{58}R^{59}$ (where R^{58} : lower alkyl, or lower alkenyl; and R^{59} : H; lower alkyl; or R^{58} and R^{59} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
- 15 $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_6PO(OR^{60})_2$ (where R^{60} : lower alkyl; or lower alkenyl); $-(CH_2)_6SO_2R^{62}$ (where R^{62} : lower alkyl; or lower alkenyl); or $-(CH_2)_qC_6H_4R^8$ (where R^8 : H; F; Cl; CF₃; lower alkyl; lower alkenyl; or lower alkoxy);
- 20 - R^{24} : lower alkyl; lower alkenyl; $-(CH_2)_6OR^{55}$ (where R^{55} : lower alkyl; or lower alkenyl); $-(CH_2)_6SR^{56}$ (where R^{56} : lower alkyl; or lower alkenyl); $-(CH_2)_6NR^{33}R^{34}$ (where R^{33} : lower alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or R^{33} and R^{34} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_6OCONR^{33}R^{75}$ (where R^{33} : H; or lower alkyl; or lower alkenyl; R^{75} : lower alkyl; or R^{33} and R^{75} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_6NR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or lower alkyl; R^{33} : H; or lower alkyl; or lower alkenyl; R^{82} : H; or lower alkyl; or R^{33} and R^{82} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
- 25 $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_6N(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl); particularly favoured are $NR^{20}CO$ lower alkyl ($R^{20}=H$; or lower alkyl); $-(CH_2)_6COOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl);
- 30 $-(CH_2)_6CONR^{58}R^{59}$ (where R^{58} : lower alkyl, or lower alkenyl; and R^{59} : H; lower alkyl; or R^{58} and R^{59} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_6PO(OR^{60})_2$ (where R^{60} : lower alkyl; or lower alkenyl); $-(CH_2)_6SO_2R^{62}$ (where R^{62} : lower alkyl; or lower alkenyl); or $-(CH_2)_qC_6H_4R^8$ (where R^8 : H; F; Cl; CF₃; lower alkyl; lower alkenyl; or lower alkoxy);

- $-(CH_2)_oCONR^{58}R^{59}$ (where R^{58} : lower alkyl, or lower alkenyl; and R^{59} : H; lower alkyl; or R^{58} and R^{59} taken together form: $-(CH_2)_{2-6-}$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_oPO(OR^{60})_2$ (where R^{60} : lower alkyl; or lower alkenyl); $-(CH_2)_oSO_2R^{62}$ (where R^{62} : lower alkyl; or lower alkenyl); or
 5 $-(CH_2)_qC_6H_4R^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl; lower alkenyl; or lower alkoxy);
 - R^{25} : H; lower alkyl; lower alkenyl; $-(CH_2)_mOR^{55}$ (where R^{55} : lower alkyl; or lower alkenyl); $-(CH_2)_mNR^{33}R^{34}$ (where R^{33} : lower alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or R^{33} and R^{34} taken together form: $-(CH_2)_{2-6-}$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_mOCONR^{33}R^{75}$ (where R^{33} : H; or
 10 lower alkyl; or lower alkenyl; R^{75} : lower alkyl; or R^{33} and R^{75} taken together form: $-(CH_2)_{2-6-}$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl);
 $-(CH_2)_mNR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or lower alkyl; R^{33} : H; or lower alkyl; or lower alkenyl; R^{82} : H; or lower alkyl; or R^{33} and R^{82} taken together form: $-(CH_2)_{2-6-}$;
 $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl);
 15 $-(CH_2)_mN(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl);
 $-(CH_2)_oCOOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(CH_2)_oCONR^{58}R^{59}$ (where R^{58} : lower alkyl; or lower alkenyl; and R^{59} : H; lower alkyl; or R^{58} and R^{59} taken together form:
 $-(CH_2)_{2-6-}$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_oPO(OR^{60})_2$ (where R^{60} : lower alkyl; or lower alkenyl); $-(CH_2)_oSO_2R^{62}$ (where
 20 R^{62} : lower alkyl; or lower alkenyl); or $-(CH_2)_qC_6H_4R^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl; lower alkenyl; or lower alkoxy).
 - R^{26} : H; lower alkyl; lower alkenyl; $-(CH_2)_mOR^{55}$ (where R^{55} : lower alkyl; or lower alkenyl); $-(CH_2)_mNR^{33}R^{34}$ (where R^{33} : lower alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or R^{33} and R^{34} taken together form: $-(CH_2)_{2-6-}$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
 25 $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_mOCONR^{33}R^{75}$ (where R^{33} : H; or lower alkyl; or lower alkenyl; R^{75} : lower alkyl; or R^{33} and R^{75} taken together form: $-(CH_2)_{2-6-}$;
 $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl);
 $-(CH_2)_mNR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or lower alkyl; R^{33} : H; or lower alkyl; or lower alkenyl; R^{82} : H; or lower alkyl; or R^{33} and R^{82} taken together form: $-(CH_2)_{2-6-}$;
 30 $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl);
 $-(CH_2)_mN(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl);
 $-(CH_2)_oCOOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(CH_2)_oCONR^{58}R^{59}$ (where R^{58} : lower alkyl; or lower alkenyl; and R^{59} : H; lower alkyl; or R^{58} and R^{59} taken together form:
 $-(CH_2)_{2-6-}$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower

- alkyl); $-(CH_2)_6PO(OR^{60})_2$ (where R^{60} : lower alkyl; or lower alkenyl); $-(CH_2)_6SO_2R^{62}$ (where R^{62} : lower alkyl; or lower alkenyl); or $-(CH_2)_qC_6H_4R^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl; lower alkenyl; or lower alkoxy).
- Alternatively, R^{25} and R^{26} taken together can be $-(CH_2)_{2-6}$; $-(CH_2)_2O(CH_2)_2$;
- 5 $-(CH_2)_2S(CH_2)_2$; or $-(CH_2)_2NR^{57}(CH_2)_2$; where R^{57} : H; or lower alkyl).
- R^{27} : H; lower alkyl; lower alkenyl; $-(CH_2)_6OR^{55}$ (where R^{55} : lower alkyl; or lower alkenyl); $-(CH_2)_6SR^{56}$ (where R^{56} : lower alkyl; or lower alkenyl); $-(CH_2)_6NR^{33}R^{34}$ (where R^{33} : lower alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or R^{33} and R^{34} taken together form: $-(CH_2)_{2-6}$; $-(CH_2)_2O(CH_2)_2$; $-(CH_2)_2S(CH_2)_2$; or $-(CH_2)_2NR^{57}(CH_2)_2$; where R^{57} : H; or lower
- 10 alkyl); $-(CH_2)_6OCONR^{33}R^{75}$ (where R^{33} : H; or lower alkyl; or lower alkenyl; R^{75} : lower alkyl; or R^{33} and R^{75} taken together form: $-(CH_2)_{2-6}$; $-(CH_2)_2O(CH_2)_2$; $-(CH_2)_2S(CH_2)_2$; or $-(CH_2)_2NR^{57}(CH_2)_2$; where R^{57} : H; or lower alkyl); $-(CH_2)_6NR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or lower alkyl; R^{33} : H; or lower alkyl; or lower alkenyl; R^{82} : H; or lower alkyl; or R^{33} and R^{82} taken together form: $-(CH_2)_{2-6}$; $-(CH_2)_2O(CH_2)_2$; $-(CH_2)_2S(CH_2)_2$; or
- 15 $-(CH_2)_2NR^{57}(CH_2)_2$; where R^{57} : H; or lower alkyl); $-(CH_2)_6N(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl); $-(CH_2)_6COOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(CH_2)_6CONR^{58}R^{59}$ (where R^{58} : lower alkyl, or lower alkenyl; and R^{59} : H; lower alkyl; or R^{58} and R^{59} taken together form: $-(CH_2)_{2-6}$; $-(CH_2)_2O(CH_2)_2$; $-(CH_2)_2S(CH_2)_2$; or $-(CH_2)_2NR^{57}(CH_2)_2$; where R^{57} : H; or lower alkyl); $-(CH_2)_6PO(OR^{60})_2$
- 20 (where R^{60} : lower alkyl; or lower alkenyl); $-(CH_2)_6SO_2R^{62}$ (where R^{62} : lower alkyl; or lower alkenyl); or $-(CH_2)_qC_6H_4R^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl; lower alkenyl; or lower alkoxy).
- R^{28} : lower alkyl; lower alkenyl; $-(CH_2)_6OR^{55}$ (where R^{55} : lower alkyl; or lower alkenyl); $-(CH_2)_6SR^{56}$ (where R^{56} : lower alkyl; or lower alkenyl); $-(CH_2)_6NR^{33}R^{34}$ (where R^{33} :
- 25 lower alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or R^{33} and R^{34} taken together form: $-(CH_2)_{2-6}$; $-(CH_2)_2O(CH_2)_2$; $-(CH_2)_2S(CH_2)_2$; or $-(CH_2)_2NR^{57}(CH_2)_2$; where R^{57} : H; or lower alkyl); $-(CH_2)_6OCONR^{33}R^{75}$ (where R^{33} : H; or lower alkyl; or lower alkenyl; R^{75} : lower alkyl; or R^{33} and R^{75} taken together form: $-(CH_2)_{2-6}$; $-(CH_2)_2O(CH_2)_2$; $-(CH_2)_2S(CH_2)_2$; or $-(CH_2)_2NR^{57}(CH_2)_2$; where R^{57} : H; or lower alkyl); $-(CH_2)_6NR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or
- 30 lower alkyl; R^{33} : H; or lower alkyl; or lower alkenyl; R^{82} : H; or lower alkyl; or R^{33} and R^{82} taken together form: $-(CH_2)_{2-6}$; $-(CH_2)_2O(CH_2)_2$; $-(CH_2)_2S(CH_2)_2$; or $-(CH_2)_2NR^{57}(CH_2)_2$; where R^{57} : H; or lower alkyl); $-(CH_2)_6N(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl); $-(CH_2)_6COOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(CH_2)_6CONR^{58}R^{59}$ (where R^{58} : lower alkyl, or lower alkenyl; and R^{59} : H; lower

- alkyl; or R⁵⁸ and R⁵⁹ taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R⁵⁷: H; or lower alkyl; $-(CH_2)_6PO(OR^{60})_2$ (where R⁶⁰: lower alkyl; or lower alkenyl); $-(CH_2)_6SO_2R^{62}$ (where R⁶²: lower alkyl; or lower alkenyl); or $-(CH_2)_qC_6H_4R^8$ (where R⁸: H; F; Cl; CF₃; lower alkyl; lower alkenyl; or lower alkoxy).
- 5 - R²⁹: lower alkyl; lower alkenyl; $-(CH_2)_6OR^{55}$ (where R⁵⁵: lower alkyl; or lower alkenyl); $-(CH_2)_6SR^{56}$ (where R⁵⁶: lower alkyl; or lower alkenyl); $-(CH_2)_6NR^{33}R^{34}$ (where R³³: lower alkyl; or lower alkenyl; R³⁴: H; or lower alkyl; or R³³ and R³⁴ taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R⁵⁷: H; or lower alkyl); $-(CH_2)_6OCONR^{33}R^{75}$ (where R³³: H; or lower alkyl; or lower alkenyl; R⁷⁵: lower alkyl; or R³³ and R⁷⁵ taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R⁵⁷: H; or lower alkyl); $-(CH_2)_6NR^{20}CONR^{33}R^{82}$ (where R²⁰: H; or lower alkyl; R³³: H; or lower alkyl; or lower alkenyl; R⁸²: H; or lower alkyl; or R³³ and R⁸² taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
- 10 - $-(CH_2)_2NR^{57}(CH_2)_2-$; where R⁵⁷: H; or lower alkyl); $-(CH_2)_6N(R^{20})COR^{64}$ (where: R²⁰: H; or lower alkyl; R⁶⁴: lower alkyl; or lower alkenyl); particularly favored are NR²⁰COlower-alkyl (R²⁰=H; or lower alkyl); $-(CH_2)_6COOR^{57}$ (where R⁵⁷: lower alkyl; or lower alkenyl); $-(CH_2)_6CONR^{58}R^{59}$ (where R⁵⁸: lower alkyl, or lower alkenyl; and R⁵⁹: H; lower alkyl; or R⁵⁸ and R⁵⁹ taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
- 15 - $-(CH_2)_2NR^{57}(CH_2)_2-$; where R⁵⁷: H; or lower alkyl); $-(CH_2)_6PO(OR^{60})_2$ (where R⁶⁰: lower alkyl; or lower alkenyl); $-(CH_2)_6SO_2R^{62}$ (where R⁶²: lower alkyl; or lower alkenyl); or $-(CH_2)_qC_6H_4R^8$ (where R⁸: H; F; Cl; CF₃; lower alkyl; lower alkenyl; or lower alkoxy).
- 20 - $-(CH_2)_2NR^{57}(CH_2)_2-$; where R⁵⁷: H; or lower alkyl); $-(CH_2)_6PO(OR^{60})_2$ (where R⁶⁰: lower alkyl; or lower alkenyl); $-(CH_2)_6SO_2R^{62}$ (where R⁶²: lower alkyl; or lower alkenyl); or $-(CH_2)_qC_6H_4R^8$ (where R⁸: H; F; Cl; CF₃; lower alkyl; lower alkenyl; or lower alkoxy).

For templates (b) to (p), such as (b1) and (c1), the preferred values for the various symbols are the following:

- 25 - R⁸: H; F; Cl; CF₃; lower alkyl; lower alkenyl; $-(CH_2)_6OR^{55}$ (where R⁵⁵: lower alkyl; or lower alkenyl); $-(CH_2)_6SR^{56}$ (where R⁵⁶: lower alkyl; or lower alkenyl); $-(CH_2)_6NR^{33}R^{34}$ (where R³³: lower alkyl; or lower alkenyl; R³⁴: H; or lower alkyl; or R³³ and R³⁴ taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R⁵⁷: H; or lower alkyl); $-(CH_2)_6OCONR^{33}R^{75}$ (where R³³: H; or lower alkyl; or lower alkenyl; R⁷⁵: lower alkyl; or R³³ and R⁷⁵ taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R⁵⁷: H; or lower alkyl); $-(CH_2)_6NR^{20}CONR^{33}R^{82}$ (where R²⁰: H; or lower alkyl; R³³: H; or lower alkyl; or lower alkenyl; R⁸²: H; or lower alkyl; or R³³ and R⁸² taken together form: $-(CH_2)_{2-6}-$;
- 30 - $-(CH_2)_2NR^{57}(CH_2)_2-$; where R⁵⁷: H; or lower alkyl); $-(CH_2)_6PO(OR^{60})_2$ (where R⁶⁰: lower alkyl; or lower alkenyl); $-(CH_2)_6SO_2R^{62}$ (where R⁶²: lower alkyl; or lower alkenyl); or $-(CH_2)_qC_6H_4R^8$ (where R⁸: H; F; Cl; CF₃; lower alkyl; lower alkenyl; or lower alkoxy).

- $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl);
 $-(CH_2)_oN(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl);
 $-(CH_2)_oCOOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(CH_2)_oCONR^{58}R^{59}$ (where R^{58} :
lower alkyl; or lower alkenyl; and R^{59} : H; or lower alkyl; or R^{58} and R^{59} taken together form:
5 $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower
alkyl); $-(CH_2)_oPO(OR^{60})_2$ (where R^{60} : lower alkyl; or lower alkenyl); $-(CH_2)_oSO_2R^{62}$ (where
 R^{62} : lower alkyl; or lower alkenyl); or $-(CH_2)_4C_6H_4R^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl;
lower alkenyl; or lower alkoxy).
- R^{20} : H; or lower alkyl.
10 - R^{30} : H, methyl.
- R^{31} : H; lower alkyl; lower alkenyl; $-(CH_2)_pOR^{55}$ (where R^{55} : lower alkyl; or lower
alkenyl); $-(CH_2)_pNR^{33}R^{34}$ (where R^{33} : lower alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or
 R^{33} and R^{34} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
 $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_pOCONR^{33}R^{75}$ (where R^{33} : H; or
15 lower alkyl; or lower alkenyl; R^{75} : lower alkyl; or R^{33} and R^{75} taken together form: $-(CH_2)_{2-6}-$; -
 $(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl);
 $-(CH_2)_pNR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or lower alkyl; R^{33} : H; or lower alkyl; or lower alkenyl;
 R^{82} : H; or lower alkyl; or R^{33} and R^{82} taken together form: $-(CH_2)_{2-6}-$;
 $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl);
20 $-(CH_2)_pN(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl);
 $-(CH_2)_oCOOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(CH_2)_oCONR^{58}R^{59}$ (where R^{58} :
lower alkyl, or lower alkenyl; and R^{59} : H; lower alkyl; or R^{58} and R^{59} taken together form:
 $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower
alkyl); $-(CH_2)_oPO(OR^{60})_2$ (where R^{60} : lower alkyl; or lower alkenyl); $-(CH_2)_oSO_2R^{62}$ (where
25 R^{62} : lower alkyl; or lower alkenyl); or $-(CH_2)_4C_6H_4R^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl;
lower alkenyl; or lower alkoxy); most preferred is $-CH_2CONR^{58}R^{59}$ (R^{58} : H; or lower alkyl; R^{59} :
lower alkyl; or lower alkenyl).
- R^{32} : H, methyl.
- R^{33} : lower alkyl; lower alkenyl; $-(CH_2)_mOR^{55}$ (where R^{55} : lower alkyl; or lower
alkenyl); $-(CH_2)_mNR^{34}R^{63}$ (where R^{34} : lower alkyl; or lower alkenyl; R^{63} : H; or lower alkyl; or
30 R^{34} and R^{63} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
 $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $(CH_2)_mOCONR^{75}R^{82}$ (where R^{75} : lower
alkyl; or lower alkenyl; R^{82} : H; or lower alkyl; or R^{75} and R^{82} taken together form: $-(CH_2)_{2-6}-$; -
 $(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl);

- $-(CH_2)_mNR^{20}CONR^{78}R^{82}$ (where R^{20} : H; or lower alkyl; R^{78} : H; or lower alkyl; or lower alkenyl; R^{82} : H; or lower alkyl; or R^{78} and R^{82} taken together form: $-(CH_2)_{2-6}$;
 $-(CH_2)_2O(CH_2)_2$; $-(CH_2)_2S(CH_2)_2$; or $-(CH_2)_2NR^{57}(CH_2)_2$; where R^{57} : H; or lower alkyl);
 $-(CH_2)_mN(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl);
 5 $-(CH_2)_6COOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(CH_2)_6CONR^{58}R^{59}$ (where R^{58} : lower alkyl; or lower alkenyl; and R^{59} : H; lower alkyl; or R^{58} and R^{59} taken together form: $-(CH_2)_{2-6}$; $-(CH_2)_2O(CH_2)_2$; $-(CH_2)_2S(CH_2)_2$; or $-(CH_2)_2NR^{57}(CH_2)_2$; where R^{57} : H; or lower alkyl).
 - R^{34} : H; or lower alkyl.
 10 - R^{35} : H; lower alkyl; lower alkenyl; $-(CH_2)_mOR^{55}$ (where R^{55} : lower alkyl; or lower alkenyl); $-(CH_2)_mNR^{33}R^{34}$ (where R^{33} : lower alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or R^{33} and R^{34} taken together form: $-(CH_2)_{2-6}$; $-(CH_2)_2O(CH_2)_2$; $-(CH_2)_2S(CH_2)_2$; or $-(CH_2)_2NR^{57}(CH_2)_2$; where R^{57} : H; or lower alkyl); $-(CH_2)_mOCONR^{33}R^{75}$ (where R^{33} : H; or lower alkyl; or lower alkenyl; R^{75} : lower alkyl; or R^{33} and R^{75} taken together form: $-(CH_2)_{2-6}$;
 15 $-(CH_2)_2O(CH_2)_2$; $-(CH_2)_2S(CH_2)_2$; or $-(CH_2)_2NR^{57}(CH_2)_2$; where R^{57} : H; or lower alkyl); $-(CH_2)_mNR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or lower alkyl; R^{33} : H; or lower alkyl; or lower alkenyl; R^{82} : H; or lower alkyl; or R^{33} and R^{82} taken together form: $-(CH_2)_{2-6}$;
 $-(CH_2)_2O(CH_2)_2$; $-(CH_2)_2S(CH_2)_2$; or $-(CH_2)_2NR^{57}(CH_2)_2$; where R^{57} : H; or lower alkyl);
 $-(CH_2)_mN(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl);
 20 $-(CH_2)_6COOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(CH_2)_6CONR^{58}R^{59}$ (where R^{58} : lower alkyl; or lower alkenyl; and R^{59} : H; lower alkyl; or R^{58} and R^{59} taken together form: $-(CH_2)_{2-6}$; $-(CH_2)_2O(CH_2)_2$; $-(CH_2)_2S(CH_2)_2$; or $-(CH_2)_2NR^{57}(CH_2)_2$; where R^{57} : H; or lower alkyl).
 - R^{36} : lower alkyl; lower alkenyl; or aryl-lower alkyl.
 25 - R^{37} : H; lower alkyl; lower alkenyl; $-(CH_2)_pOR^{55}$ (where R^{55} : lower alkyl; or lower alkenyl); $-(CH_2)_pNR^{33}R^{34}$ (where R^{33} : lower alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or R^{33} and R^{34} taken together form: $-(CH_2)_{2-6}$; $-(CH_2)_2O(CH_2)_2$; $-(CH_2)_2S(CH_2)_2$; or $-(CH_2)_2NR^{57}(CH_2)_2$; where R^{57} : H; or lower alkyl); $-(CH_2)_pOCONR^{33}R^{75}$ (where R^{33} : H; or lower alkyl; or lower alkenyl; R^{75} : lower alkyl; or R^{33} and R^{75} taken together form: $-(CH_2)_{2-6}$; -
 30 $-(CH_2)_2O(CH_2)_2$; $-(CH_2)_2S(CH_2)_2$; or $-(CH_2)_2NR^{57}(CH_2)_2$; where R^{57} : H; or lower alkyl); $-(CH_2)_pNR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or lower alkyl; R^{33} : H; or lower alkyl; or lower alkenyl; R^{82} : H; or lower alkyl; or R^{33} and R^{82} taken together form: $-(CH_2)_{2-6}$;
 $-(CH_2)_2O(CH_2)_2$; $-(CH_2)_2S(CH_2)_2$; or $-(CH_2)_2NR^{57}(CH_2)_2$; where R^{57} : H; or lower alkyl);
 $-(CH_2)_pN(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl);

- $-(CH_2)_oCOOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(CH_2)_oCONR^{58}R^{59}$ (where R^{58} : lower alkyl, or lower alkenyl; and R^{59} : H; lower alkyl; or R^{58} and R^{59} taken together form: $-(CH_2)_{2-6-}$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_oPO(OR^{60})_2$ (where R^{60} : lower alkyl; or lower alkenyl); $-(CH_2)_oSO_2R^{62}$ (where R^{62} : lower alkyl; or lower alkenyl); or $-(CH_2)_qC_6H_4R^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl; lower alkenyl; or lower alkoxy).
- R^{38} : H; lower alkyl; lower alkenyl; $-(CH_2)_pOR^{55}$ (where R^{55} : lower alkyl; or lower alkenyl); $-(CH_2)_pNR^{33}R^{34}$ (where R^{33} : lower alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or R^{33} and R^{34} taken together form: $-(CH_2)_{2-6-}$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
- 10 $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_pOCONR^{33}R^{75}$ (where R^{33} : H; or lower alkyl; or lower alkenyl; R^{75} : lower alkyl; or R^{33} and R^{75} taken together form: $-(CH_2)_{2-6-}$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_pNR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or lower alkyl; R^{33} : H; or lower alkyl; or lower alkenyl; R^{82} : H; or lower alkyl; or R^{33} and R^{82} taken together form: $-(CH_2)_{2-6-}$;
- 15 $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_pN(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl); $-(CH_2)_oCOOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(CH_2)_oCONR^{58}R^{59}$ (where R^{58} : lower alkyl, or lower alkenyl; and R^{59} : H; lower alkyl; or R^{58} and R^{59} taken together form: $-(CH_2)_{2-6-}$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower
- 20 alkyl); $-(CH_2)_oPO(OR^{60})_2$ (where R^{60} : lower alkyl; or lower alkenyl); $-(CH_2)_oSO_2R^{62}$ (where R^{62} : lower alkyl; or lower alkenyl); or $-(CH_2)_qC_6H_4R^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl; lower alkenyl; or lower alkoxy).
- R^{39} : H; lower alkyl; lower alkenyl; $-(CH_2)_mOR^{55}$ (where R^{55} : lower alkyl; or lower alkenyl); $-(CH_2)_mN(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower
- 25 alkenyl); $-(CH_2)_oCOOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(CH_2)_oCONR^{58}R^{59}$ (where R^{58} : lower alkyl; or lower alkenyl; and R^{59} : H; lower alkyl; or R^{58} and R^{59} taken together form: $-(CH_2)_{2-6-}$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl).
- R^{40} : lower alkyl; lower alkenyl; or aryl-lower alkyl.
- 30 - R^{41} : H; lower alkyl; lower alkenyl; $-(CH_2)_pOR^{55}$ (where R^{55} : lower alkyl; or lower alkenyl); $-(CH_2)_pNR^{33}R^{34}$ (where R^{33} : lower alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or R^{33} and R^{34} taken together form: $-(CH_2)_{2-6-}$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
- $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_pOCONR^{33}R^{75}$ (where R^{33} : H; or lower alkyl; or lower alkenyl; R^{75} : lower alkyl; or R^{33} and R^{75} taken together form: $-(CH_2)_{2-6-}$;

- $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl);
 $-(CH_2)_pNR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or lower alkyl; R^{33} : H; or lower alkyl; or lower alkenyl;
 R^{82} : H; or lower alkyl; or R^{33} and R^{82} taken together form: $-(CH_2)_{2-6}-$;
 $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl);
5 $-(CH_2)_pN(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl);
 $-(CH_2)_oCOOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(CH_2)_oCONR^{58}R^{59}$ (where R^{58} :
lower alkyl, or lower alkenyl; and R^{59} : H; lower alkyl; or R^{58} and R^{59} taken together form:
 $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower
alkyl); $-(CH_2)_oPO(OR^{60})_2$ (where R^{60} : lower alkyl; or lower alkenyl); $-(CH_2)_oSO_2R^{62}$ (where
10 R^{62} : lower alkyl; or lower alkenyl); or $-(CH_2)_qC_6H_4R^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl;
lower alkenyl; or lower alkoxy).
- R^{42} : H; lower alkyl; lower alkenyl; $-(CH_2)_pOR^{55}$ (where R^{55} : lower alkyl; or lower
alkenyl); $-(CH_2)_pNR^{33}R^{34}$ (where R^{33} : lower alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or
 R^{33} and R^{34} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
15 $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_pOCONR^{33}R^{75}$ (where R^{33} : H; or
lower alkyl; or lower alkenyl; R^{75} : lower alkyl; or R^{33} and R^{75} taken together form: $-(CH_2)_{2-6}-$;
 $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl);
 $-(CH_2)_pNR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or lower alkyl; R^{33} : H; or lower alkyl; or lower alkenyl;
 R^{82} : H; or lower alkyl; or R^{33} and R^{82} taken together form: $-(CH_2)_{2-6}-$;
20 $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl);
 $-(CH_2)_pN(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl);
 $-(CH_2)_oCOOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(CH_2)_oCONR^{58}R^{59}$ (where R^{58} :
lower alkyl, or lower alkenyl; and R^{59} : H; lower alkyl; or R^{58} and R^{59} taken together form:
 $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower
25 alkyl); $-(CH_2)_oPO(OR^{60})_2$ (where R^{60} : lower alkyl; or lower alkenyl); $-(CH_2)_oSO_2R^{62}$ (where
 R^{62} : lower alkyl; or lower alkenyl); or $-(CH_2)_qC_6H_4R^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl;
lower alkenyl; or lower alkoxy).
- R^{43} : H; lower alkyl; lower alkenyl; $-(CH_2)_mOR^{55}$ (where R^{55} : lower alkyl; or lower
alkenyl); $-(CH_2)_mSR^{56}$ (where R^{56} : lower alkyl; or lower alkenyl); $-(CH_2)_mNR^{33}R^{34}$ (where R^{33} :
30 lower alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or R^{33} and R^{34} taken together form:
 $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower
alkyl); $-(CH_2)_mOCONR^{33}R^{75}$ (where R^{33} : H; or lower alkyl; or lower alkenyl; R^{75} : lower alkyl;
or R^{33} and R^{75} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
 $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_mNR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or

- lower alkyl; R^{33} : H; or lower alkyl; or lower alkenyl; R^{82} : H; or lower alkyl; or R^{33} and R^{82} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl; $-(CH_2)_mN(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl); $-(CH_2)_6COOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(CH_2)_6CONR^{58}R^{59}$ (where R^{58} : lower alkyl; or lower alkenyl; and R^{59} : H; lower alkyl; or R^{58} and R^{59} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_6PO(OR^{60})_2$ (where R^{60} : lower alkyl; or lower alkenyl); $-(CH_2)_6SO_2R^{62}$ (where R^{62} : lower alkyl; or lower alkenyl); or $-(CH_2)_6C_6H_4R^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl; lower alkenyl; or lower alkoxy).
- R^{44} : lower alkyl; lower alkenyl; $-(CH_2)_pOR^{55}$ (where R^{55} : lower alkyl; or lower alkenyl); $-(CH_2)_pSR^{56}$ (where R^{56} : lower alkyl; or lower alkenyl); $-(CH_2)_pNR^{33}R^{34}$ (where R^{33} : lower alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or R^{33} and R^{34} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_pOCONR^{33}R^{75}$ (where R^{33} : H; or lower alkyl; or lower alkenyl; R^{75} : lower alkyl; or R^{33} and R^{75} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_pNR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or lower alkyl; R^{33} : H; or lower alkyl; or lower alkenyl; R^{82} : H; or lower alkyl; or R^{33} and R^{82} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_pN(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl); $-(CH_2)_pCOOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(CH_2)_pCONR^{58}R^{59}$ (where R^{58} : lower alkyl; or lower alkenyl; and R^{59} : H; lower alkyl; or R^{58} and R^{59} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); or $-(CH_2)_6C_6H_4R^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl; lower alkenyl; or lower alkoxy).
- R^{45} : H; lower alkyl; lower alkenyl; $-(CH_2)_6OR^{55}$ (where R^{55} : lower alkyl; or lower alkenyl); $-(CH_2)_6SR^{56}$ (where R^{56} : lower alkyl; or lower alkenyl); $-(CH_2)_6NR^{33}R^{34}$ (where R^{33} : lower alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or R^{33} and R^{34} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_6OCONR^{33}R^{75}$ (where R^{33} : H; or lower alkyl; or lower alkenyl; R^{75} : lower alkyl; or R^{33} and R^{75} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_6NR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or lower alkyl; R^{33} : H; or lower alkyl; or lower alkenyl; R^{82} : H; or lower alkyl; or R^{33} and R^{82} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or

- $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl; $-(CH_2)_oN(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl); $-(CH_2)_oCOOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(CH_2)_oCONR^{58}R^{59}$ (where R^{58} : lower alkyl; or lower alkenyl; and R^{59} : H; lower alkyl; or R^{58} and R^{59} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$;
- 5 $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl; or $-(CH_2)_sC_6H_4R^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl; lower alkenyl; or lower alkoxy).
- R^{46} : H; lower alkyl; lower alkenyl; $-(CH_2)_sOR^{55}$ (where R^{55} : lower alkyl; or lower alkenyl); $-(CH_2)_sSR^{56}$ (where R^{56} : lower alkyl; or lower alkenyl); $-(CH_2)_sNR^{33}R^{34}$ (where R^{33} : lower alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or R^{33} and R^{34} taken together form:
- 10 $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl; $-(CH_2)_sOCONR^{33}R^{75}$ (where R^{33} : H; or lower alkyl; or lower alkenyl; R^{75} : lower alkyl; or R^{33} and R^{75} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
- $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_sNR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or lower alkyl; R^{33} : H; or lower alkyl; or lower alkenyl; R^{82} : H; or lower alkyl; or R^{33} and R^{82}
- 15 taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
- $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_sN(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl); $-(CH_2)_oCOOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(CH_2)_oCONR^{58}R^{59}$ (where R^{58} : lower alkyl; or lower alkenyl; and R^{59} : H; lower alkyl; or R^{58} and R^{59} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$;
- 20 $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl; or $-(CH_2)_sC_6H_4R^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl; lower alkenyl; or lower alkoxy).
- R^{47} : H; or OR^{55} (where R^{55} : lower alkyl; or lower alkenyl).
- R^{48} : H; or lower alkyl.
- R^{49} : H; lower alkyl; $-(CH_2)_oCOOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl);
- 25 $-(CH_2)_oCONR^{58}R^{59}$ (where R^{58} : lower alkyl; or lower alkenyl; and R^{59} : H; lower alkyl; or R^{58} and R^{59} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
- $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl; or $(CH_2)_sC_6H_4R^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl; lower alkenyl; or lower alkoxy).
- R^{50} : H; methyl.
- 30 - R^{51} : H; lower alkyl; lower alkenyl; $-(CH_2)_mOR^{55}$ (where R^{55} : lower alkyl; or lower alkenyl); $-(CH_2)_mNR^{33}R^{34}$ (where R^{33} : lower alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or R^{33} and R^{34} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
- $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $(CH_2)_mOCONR^{33}R^{75}$ (where R^{33} : H; or lower alkyl; or lower alkenyl; R^{75} : lower alkyl; or R^{33} and R^{75} taken together form: $-(CH_2)_{2-6}-$;

- $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl);
 $-(CH_2)_mNR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or lower alkyl; R^{33} : H; or lower alkyl; or lower
 alkenyl; R^{82} : H; or lower alkyl; or R^{33} and R^{82} taken together form: $-(CH_2)_{2-6}-$;
 $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl);
 5 $-(CH_2)_mN(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl);
 $-(CH_2)_pCOOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(CH_2)_pCONR^{58}R^{59}$ (where R^{58} :
 lower alkyl; or lower alkenyl; and R^{59} : H; lower alkyl; or R^{58} and R^{59} taken together form:
 $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower
 alkyl); or $-(CH_2)_rC_6H_4R^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl; lower alkenyl; or lower
 10 alkoxy).
 - R^{52} : H; lower alkyl; lower alkenyl; $-(CH_2)_mOR^{55}$ (where R^{55} : lower alkyl; or lower
 alkenyl); $-(CH_2)_mNR^{33}R^{34}$ (where R^{33} : lower alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or
 R^{33} and R^{34} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
 $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_mOCONR^{33}R^{75}$ (where R^{33} : H; or
 15 lower alkyl; or lower alkenyl; R^{75} : lower alkyl; or R^{33} and R^{75} taken together form: $-(CH_2)_{2-6}-$;
 $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl);
 $-(CH_2)_mNR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or lower alkyl; R^{33} : H; or lower alkyl; or lower
 alkenyl; R^{82} : H; or lower alkyl; or R^{33} and R^{82} taken together form: $-(CH_2)_{2-6}-$;
 $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; R^{57} : H; or lower alkyl);
 20 $-(CH_2)_mN(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl);
 $-(CH_2)_pCOOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(CH_2)_pCONR^{58}R^{59}$ (where R^{58} :
 lower alkyl; or lower alkenyl; and R^{59} : H; lower alkyl; or R^{58} and R^{59} taken together form:
 $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower
 alkyl); or $-(CH_2)_rC_6H_4R^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl; lower alkenyl; or lower
 25 alkoxy).
 - R^{53} : H; lower alkyl; lower alkenyl; $-(CH_2)_mOR^{55}$ (where R^{55} : lower alkyl; or lower
 alkenyl); $-(CH_2)_mNR^{33}R^{34}$ (where R^{33} : lower alkyl; or lower alkenyl; R^{34} : H; or lower alkyl; or
 R^{33} and R^{34} taken together form: $-(CH_2)_{2-6}-$; $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or
 $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl); $-(CH_2)_mOCONR^{33}R^{75}$ (where R^{33} : H; or
 30 lower alkyl; or lower alkenyl; R^{75} : lower alkyl; or R^{33} and R^{75} taken together form: $-(CH_2)_{2-6}-$;
 $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl);
 $-(CH_2)_mNR^{20}CONR^{33}R^{82}$ (where R^{20} : H; or lower alkyl; R^{33} : H; or lower alkyl; or lower
 alkenyl; R^{82} : H; or lower alkyl; or R^{33} and R^{82} taken together form: $-(CH_2)_{2-6}-$;
 $-(CH_2)_2O(CH_2)_2-$; $-(CH_2)_2S(CH_2)_2-$; or $-(CH_2)_2NR^{57}(CH_2)_2-$; where R^{57} : H; or lower alkyl);

- $-(CH_2)_mN(R^{20})COR^{64}$ (where: R^{20} : H; or lower alkyl; R^{64} : lower alkyl; or lower alkenyl);
 $-(CH_2)_pCOOR^{57}$ (where R^{57} : lower alkyl; or lower alkenyl); $-(CH_2)_pCONR^{58}R^{59}$ (where R^{58} :
 lower alkyl; or lower alkenyl; and R^{59} : H; lower alkyl; or R^{58} and R^{59} taken together form:
 $-(CH_2)_{2-6}$; $-(CH_2)_2O(CH_2)_2$; $-(CH_2)_2S(CH_2)_2$; or $-(CH_2)_2NR^{57}(CH_2)_2$; where R^{57} : H; or lower
 5 alkyl); or $-(CH_2)_rC_6H_4R^8$ (where R^8 : H; F; Cl; CF_3 ; lower alkyl; lower alkenyl; or lower
 alkoxy).
 - R^{54} : lower alkyl; lower alkenyl; or aryl-lower alkyl.

Among the building blocks A70 to A104 the following are preferred: A74 with R^{22} being H,
 10 A75, A76, A77 with R^{22} being H, A78 and A79.

The building block -B-CO- within template (a1) through (a4) designates an L-amino acid
 residue. Preferred values for B are: $-NR^{20}CH(R^{71})-$ and enantiomers of groups A5 with R^2
 being H, A8, A22, A25, A38 with R^2 being H, A42, A47, and A50. Most preferred are

15	Asn	L-Asparagine
	Cys	L-Cysteine
	Gln	L-Glutamine
	His	L-Histidine
	Met	L-Methionine
20	Phe	L-Phenylalanine
	Pro	L-Proline
	Ser	L-Serine
	Thr	L-Threonine
	Trp	L-Tryptophan
25	Tyr	L-Tyrosine
	Sar	Sarcosine
	4AmPhe	L-para-Aminophenylalanine
	3AmPhe	L-meta-Aminophenylalanine
	2AmPhe	L-ortho-Aminophenylalanine
30	Phe(mC(NH ₂)=NH)	L-meta-Amidinophenylalanine
	Phe(pC(NH ₂)=NH)	L-para-Amidinophenylalanine
	Phe(mNHC(NH ₂)=NH)	L-meta-Guanidinophenylalanine
	Phe(pNHC(NH ₂)=NH)	L-para-Guanidinophenylalanine
	Phg	L-Phenylglycine

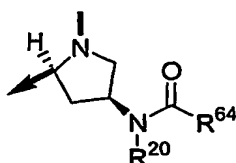
	Cha	L-Cyclohexylalanine
	C ₄ al	L-3-Cyclobutylalanine
	C ₅ al	L-3-Cyclopentylalanine
	2-Nal	L-2-Naphthylalanine
5	1-Nal	L-1-Naphthylalanine
	4Cl-Phe	L-4-Chlorophenylalanine
	3Cl-Phe	L-3-Chlorophenylalanine
	2Cl-Phe	L-2-Chlorophenylalanine
	3,4Cl ₂ Phe	L-3,4-Dichlorophenylalanine
10	4F-Phe	L-4-Fluorophenylalanine
	3F-Phe	L-3-Fluorophenylalanine
	2F-Phe	L-2-Fluorophenylalanine
	Tic	L-1,2,3,4-Tetrahydroisoquinoline-3-carboxylic acid
	Thi	L-β-2-Thienylalanine
15	Tza	L-2-Thiazolylalanine
	Mso	L-Methionine sulfoxide
	Y(Bzl)	L-O-Benzyltyrosine
	Bip	L-Biphenylalanine
	S(Bzl)	L-O-Benzylserine
20	T(Bzl)	L-O-Benzylthreonine
	hCha	L-Homo-cyclohexylalanine
	hCys	L-Homo-cysteine
	hSer	L-Homo-serine
	hPhe	L-Homo-phenylalanine
25	Bpa	L-4-Benzoylphenylalanine
	Pip	L-Pipecolic acid
	OctG	L-Octylglycine
	MePhe	L-N-Methylphenylalanine
	MeNle	L-N-Methylnorleucine
30	MeAla	L-N-Methylalanine
	MeIle	L-N-Methylisoleucine
	MeVal	L-N-Methvaline
	MeLeu	L-N-Methylleucine

In template (a4), an additional preferred value for the building block -B-CO- is

AMPA

3-Aminomethyphenyl acetic acid

In addition, the most preferred values for **B** also include groups of type **A8''** of (L)-
5 configuration:



A8''

wherein R^{20} is H or lower alkyl and R^{64} is alkyl; alkenyl; aryl; aryl-lower alkyl; or heteroaryl-
10 lower alkyl; especially those wherein R^{64} is n-hexyl (**A8''-21**); n-heptyl (**A8''-22**); 4-
(phenyl)benzyl (**A8''-23**); diphenylmethyl (**A8''-24**); 3-amino-propyl (**A8''-25**); 5-amino-
pentyl (**A8''-26**); methyl (**A8''-27**); ethyl (**A8''-28**); isopropyl (**A8''-29**); isobutyl (**A8''-30**); n-
propyl (**A8''-31**); cyclohexyl (**A8''-32**); cyclohexylmethyl (**A8''-33**); n-butyl (**A8''-34**); phenyl
15 (**A8''-35**); benzyl (**A8''-36**); (3-indolyl)methyl (**A8''-37**); 2-(3-indolyl)ethyl (**A8''-38**); (4-
phenyl)phenyl (**A8''-39**); and n-nonyl (**A8''-40**).

The peptidic chains **Z** and **Z'** of the β -hairpin mimetics described herein are generally defined
in terms of amino acid residues belonging to one of the following groups:

- | | | |
|----|-----------|---|
| - | Group C | $-\text{NR}^{20}\text{CH}(\text{R}^{72})\text{CO}-$; "hydrophobic: small to medium-sized" |
| 20 | - Group D | $-\text{NR}^{20}\text{CH}(\text{R}^{73})\text{CO}-$; "hydrophobic: large aromatic or heteroaromatic" |
| - | Group E | $-\text{NR}^{20}\text{CH}(\text{R}^{74})\text{CO}-$; "polar-cationic" and "urea-derived" |
| - | Group F | $-\text{NR}^{20}\text{CH}(\text{R}^{84})\text{CO}-$; "polar-non-charged" |
| - | Group H | $-\text{NR}^{20}-\text{CH}(\text{CO}-)(\text{CH}_2)_{4-7}-\text{CH}(\text{CO}-)\text{NR}^{20}-$; |
| 25 | | $-\text{NR}^{20}-\text{CH}(\text{CO}-)(\text{CH}_2)_p\text{SS}(\text{CH}_2)_p-\text{CH}(\text{CO}-)\text{NR}^{20}-$; |
| | | $-\text{NR}^{20}-\text{CH}(\text{CO}-)(-\text{CH}_2)_p\text{NR}^{20}\text{CO}(\text{CH}_2)_p-\text{CH}(\text{CO}-)\text{NR}^{20}-$; and |
| | | $-\text{NR}^{20}-\text{CH}(\text{CO}-)(-\text{CH}_2)_p\text{NR}^{20}\text{CONR}^{20}(\text{CH}_2)_p-\text{CH}(\text{CO}-)\text{NR}^{20}-$; |
| | | "interstrand linkage" |
| | Group I | $-\text{NR}^{86}\text{CH}_2\text{CO}-$; "polar-cationic" |

30

Furthermore, Gly can also be an amino acid residue in chains Z and Z¹, and Pro can be an amino acid residue in chains Z and Z¹, too, with the exception of positions where interstrand linkages (H) are possible.

5 **Group C** comprises amino acid residues with small to medium-sized hydrophobic side chain groups according to the general definition for substituent R⁷². A hydrophobic residue refers to an amino acid side chain that is uncharged at physiological pH and that is repelled by aqueous solution. Furthermore these side chains generally do not contain hydrogen bond donor groups, such as (but not limited to) primary and secondary amides, primary and secondary amines and
10 the corresponding protonated salts thereof, thiols, alcohols, phosphonates, phosphates, ureas or thioureas. However, they may contain hydrogen bond acceptor groups such as ethers, thioethers, esters, tertiary amides, alkyl- or aryl phosphonates and phosphates or tertiary amines. Genetically encoded small-to-medium-sized amino acids include alanine, isoleucine, leucine, methionine and valine.

15 **Group D** comprises amino acid residues with aromatic and heteroaromatic side chain groups according to the general definition for substituent R⁷³. An aromatic amino acid residue refers to a hydrophobic amino acid having a side chain containing at least one ring having a conjugated π -electron system (aromatic group). In addition they may contain hydrogen bond donor groups
20 such as (but not limited to) primary and secondary amides, primary and secondary amines and the corresponding protonated salts thereof, thiols, alcohols, phosphonates, phosphates, ureas or thioureas, and hydrogen bond acceptor groups such as (but not limited to) ethers, thioethers, esters, tertiary amides, alkyl- or aryl phosphonates -and phosphates or tertiary amines. Genetically encoded aromatic amino acids include phenylalanine and tyrosine.

25 A heteroaromatic amino acid residue refers to a hydrophobic amino acid having a side chain containing at least one ring having a conjugated π -system incorporating at least one heteroatom such as (but not limited to) O, S and N according to the general definition for substituent R⁷⁷. In addition such residues may contain hydrogen bond donor groups such as (but not limited to)
30 primary and secondary amides, primary and secondary amines and the corresponding protonated salts thereof, thiols, alcohols, phosphonates, phosphates, ureas or thioureas, and hydrogen bond acceptor groups such as (but not limited to) ethers, thioethers, esters, tertiary amides, alkyl- or aryl phosphonates -and phosphates or tertiary amines. Genetically encoded heteroaromatic amino acids include tryptophan and histidine.

Group E comprises amino acids containing side chains with polar-cationic, acylamino- and urea-derived residues according to the general definition for substituent R^{74} . Polar-cationic refers to a basic side chain which is protonated at physiological pH. Genetically encoded polar-cationic amino acids include arginine, lysine and histidine. Citrulline is an example for an urea derived amino acid residue.

Group F comprises amino acids containing side chains with polar-non-charged residues according to the general definition for substituent R^{84} . A polar-non-charged residue refers to a hydrophilic side chain that is uncharged at physiological pH, but that is not repelled by aqueous solutions. Such side chains typically contain hydrogen bond donor groups such as (but not limited to) primary and secondary amides, primary and secondary amines, thiols, alcohols, phosphonates, phosphates, ureas or thioureas. These groups can form hydrogen bond networks with water molecules. In addition they may also contain hydrogen bond acceptor groups such as (but not limited to) ethers, thioethers, esters, tertiary amides, alkyl- or aryl phosphonates - and phosphates or tertiary amines. Genetically encoded polar-non-charged amino acids include asparagine, cysteine, glutamine, serine and threonine.

Group H comprises side chains of preferably (L)-amino acids at opposite positions of the β -strand region that can form an interstrand linkage. The most widely known linkage is the disulfide bridge formed by cysteines and homo-cysteines positioned at opposite positions of the β -strand. Various methods are known to form disulfide linkages including those described by: J. P. Tam et al. *Synthesis* 1979, 955-957; Stewart et al. , *Solid Phase Peptide Synthesis*, 2d Ed., Pierce Chemical Company, III., 1984; Ahmed et al. *J. Biol. Chem.* 1975, 250, 8477-8482 ; and Pennington et al., *Peptides*, pages 164-166, Giralt and Andreu, Eds., ESCOM Leiden, The Netherlands, 1990. Most advantageously, for the scope of the present invention, disulfide linkages can be prepared using acetamidomethyl (Acm)- protective groups for cysteine. A well established interstrand linkage consists in linking ornithines and lysines, respectively, with glutamic and aspartic acid residues located at opposite β -strand positions by means of an amide bond formation. Preferred protective groups for the side chain amino-groups of ornithine and lysine are allyloxycarbonyl (Alloc) and allylesters for aspartic and glutamic acid. Finally, interstrand linkages can also be established by linking the amino groups of lysine and ornithine

located at opposite β -strand positions with reagents such as N,N-carbonylimidazole to form cyclic ureas.

- Group I** comprises glycine having the amino group substituted by chains containing polar-cationic residues according to the general definition for substituent R⁸⁶. Polar-cationic refers to a basic side chain which is protonated at physiological pH.

As mentioned earlier, positions for interstrand linkages are the following:

- 10 If n is 4 and n' is 6 Positions P3 and P3' taken together
If n is 5 and n' is 7 Positions P2 and P2' and/or P4 and P4', taken together

Such interstrand linkages are known to stabilize the β -hairpin conformations and thus constitute an important structural element for the design of β -hairpin mimetics.

- 15 Most preferred amino acid residues in chains Z and Z' are those derived from natural α -amino acids. Hereinafter follows a list of amino acids which, or the residues of which, are suitable for the purposes of the present invention, the abbreviations corresponding to generally adopted usual practice:

20	three letter code		one letter code
	Ala	L-Alanine	A
	Arg	L-Arginine	R
25	Asn	L-Asparagine	N
	Asp	L-Aspartic acid	D
	Cys	L-Cysteine	C
	Glu	L-Glutamic acid	E
	Gln	L-Glutamine	Q
30	Gly	Glycine	G
	His	L-Histidine	H
	Ile	L-Isoleucine	I
	Leu	L-Leucine	L

	Lys	L-Lysine	K
	Met	L-Methionine	M
	Phe	L-Phenylalanine	F
	Pro	L-Proline	P
5	^D Pro	D-Proline	^D P
	Ser	L-Serine	S
	Thr	L-Threonine	T
	Trp	L-Tryptophan	W
	Tyr	L-Tyrosine	Y
10	Val	L-Valine	V

Other α -amino acids which, or the residues of which, are suitable for the purposes of the present invention include:

	Cit	L-Citrulline
15	Orn	L-Ornithine
	tBuA	L-t-Butylalanine
	Sar	Sarcosine
	Pen	L-Penicillamine
	t-BuG	L-tert.-Butylglycine
20	4AmPhe	L-para-Aminophenylalanine
	3AmPhe	L-meta-Aminophenylalanine
	2AmPhe	L-ortho-Aminophenylalanine
	Phe(mC(NH ₂)=NH)	L-meta-Amidinophenylalanine
	Phe(pC(NH ₂)=NH)	L-para-Amidinophenylalanine
25	Phe(mNHC (NH ₂)=NH)	L-meta-Guanidinophenylalanine
	Phe(pNHC (NH ₂)=NH)	L-para-Guanidinophenylalanine
	Phg	L-Phenylglycine
	Cha	L-Cyclohexylalanine
	C ₄ al	L-3-Cyclobutylalanine
30	C ₅ al	L-3-Cyclopentylalanine
	Nle	L-Norleucine
	2-Nal	L-2-Naphthylalanine
	1-Nal	L-1-Naphthylalanine
	4Cl-Phe	L-4-Chlorophenylalanine

	3Cl-Phe	L-3-Chlorophenylalanine
	2Cl-Phe	L-2-Chlorophenylalanine
	3,4Cl ₂ -Phe	L-3,4-Dichlorophenylalanine
	4F-Phe	L-4-Fluorophenylalanine
5	3F-Phe	L-3-Fluorophenylalanine
	2F-Phe	L-2-Fluorophenylalanine
	Tic	1,2,3,4-Tetrahydroisoquinoline-3-carboxylic acid
	Thi	L-β-2-Thienylalanine
	Tza	L-2-Thiazolylalanine
10	Mso	L-Methionine sulfoxide
	AcLys	N-Acetyllysine
	Dpr	2,3-Diaminopropionic acid
	A ₂ Bu	2,4-Diaminobutyric acid
	Dbu	(S)-2,3-Diaminobutyric acid
15	Abu	γ-Aminobutyric acid (GABA)
	Aha	ε-Aminohexanoic acid
	Aib	α-Aminoisobutyric acid
	Y(Bzl)	L-O-Benzyltyrosine
	Bip	L-(4-phenyl)phenylalanine
20	S(Bzl)	L-O-Benzylserine
	T(Bzl)	L-O-Benzylthreonine
	hCha	L-Homo-cyclohexylalanine
	hCys	L-Homo-cysteine
	hSer	L-Homo-serine
25	hArg	L-Homo-arginine
	hPhe	L-Homo-phenylalanine
	Bpa	L-4-Benzoylphenylalanine
	4-AmPyr _{rr} 1	(2S,4S)-4-Amino-pyrrolidine-L-carboxylic acid
	4-AmPyr _{rr} 2	(2S,4R)-4-Amino-pyrrolidine-L-carboxylic acid
30	4-PhePyr _{rr} 1	(2S,5R)-4-Phenyl-pyrrolidine-L-carboxylic acid
	4-PhePyr _{rr} 2	(2S,5S)-4-Phenyl-pyrrolidine-L-carboxylic acid
	5-PhePyr _{rr} 1	(2S,5R)-5-Phenyl-pyrrolidine-L-carboxylic acid
	5-PhePyr _{rr} 2	(2S,5S)-5-Phenyl-pyrrolidine-L-carboxylic acid

	Pro(4-OH)1	(4S)-L-Hydroxyproline
	Pro(4-OH)2	(4R)-L-Hydroxyproline
	Pip	L-Pipecolic acid
	^D Pip	D-Pipecolic acid
5	OctG	L-Octylglycine
	MePhe	L-N-Methylphenylalanine
	MeNle	L-N-Methylnorleucine
	MeAla	L-N-Methylalanine
	MeIle	L-N-Methylisoleucine
10	MeVal	L-N-Methylvaline
	MeLeu	L-N-Methylleucine
	W(6-Cl)	L-6-Cl-Tryptophan
	(EA)G	N-(2-Aminoethyl)glycine
	(PrA)G	N-(3-Amino-n-propyl)glycine
15	(BA)G	N-(4-Amino-n-butyl)glycine
	(PeA)G	N-(5-Amino-n-pentyl)glycine
	(EGU)G	N-(2-Guanidinoethyl)glycine
	(PrGU)G	N-(3-Guanidino-n-propyl)glycine
	(BGU)G	N-(4-Guanidino-n-butyl)glycine
20	(PeGU)G	N-(5-Guanidino-n-pentyl)glycine
	(PEG ₃ -NH ₂)G	N-[(CH ₂) ₃ O-(CH ₂ -CH ₂ O) ₂ -(CH ₂) ₃ -NH ₂]glycine

Particularly preferred residues for **group C** are:

25	Ala	L-Alanine
	Ile	L-Isoleucine
	Leu	L-Leucine
	Met	L-Methionine
	Val	L-Valine
30	tBuA	L-t-Butylalanine
	t-BuG	L-tert.-Butylglycine
	Cha	L-Cyclohexylalanine
	C ₄ al	L-3-Cyclobutylalanine

	C ₅ al	L-3-Cyclopentylalanine
	Nle	L-Norleucine
	hCha	L-Homo-cyclohexylalanine
	OctG	L-Octylglycine
5	MePhe	L-N-Methylphenylalanine
	MeNle	L-N-Methylnorleucine
	MeAla	L-N-Methylalanine
	Melle	L-N-Methylisoleucine
	MeVal	L-N-Methylvaline
10	MeLeu	L-N-Methylleucine

Particularly preferred residues for **group D** are:

	His	L-Histidine
	Phe	L-Phenylalanine
15	Trp	L-Tryptophan
	Tyr	L-Tyrosine
	Phg	L-Phenylglycine
	2-Nal	L-2-Naphthylalanine
	1-Nal	L-1-Naphthylalanine
20	4Cl-Phe	L-4-Chlorophenylalanine
	3Cl-Phe	L-3-Chlorophenylalanine
	2Cl-Phe	L-2-Chlorophenylalanine
	3,4Cl ₂ -Phe	L-3,4-Dichlorophenylalanine
	4F-Phe	L-4-Fluorophenylalanine
25	3F-Phe	L-3-Fluorophenylalanine
	2F-Phe	L-2-Fluorophenylalanine
	Thi	L-β-2-Thienylalanine
	Tza	L-2-Thiazolylalanine
	Y(Bzl)	L-O-Benzyltyrosine
30	Bip	L-Biphenylalanine
	S(Bzl)	L-O-Benzylserine
	T(Bzl)	L-O-Benzylthreonine
	hPhe	L-Homo-phenylalanine
	Bpa	L-4-Benzoylphenylalanine

W(6-Cl)

L-6-Cl-Tryptophan

Particularly preferred residues for **group E** are

5	Arg	L-Arginine
	Lys	L-Lysine
	Orn	L-Ornithine
	Dpr	L-2,3-Diaminopropionic acid
	A ₂ Bu	L-2,4-Diaminobutyric acid
10	Dbu	(S)-2,3-Diaminobutyric acid
	F(pNH ₂)	L-para-Aminophenylalanine
	Phe(mNH ₂)	L-meta-Aminophenylalanine
	Phe(oNH ₂)	L-ortho-Aminophenylalanine
	hArg	L-Homo-arginine
15	Phe(mC(NH ₂)=NH)	L-meta-Amidinophenylalanine
	Phe(pC(NH ₂)=NH)	L-para-Amidinophenylalanine
	Phe(mNHC (NH ₂)=NH)	L-meta-Guanidinophenylalanine
	Phe(pNHC (NH ₂)=NH)	L-para-Guanidinophenylalanine

20

Particularly preferred residues for **group F** are

	Asn	L-Asparagine
	Cys	L-Cysteine
	Gln	L-Glutamine
25	Ser	L-Serine
	Thr	L-Threonine
	Cit	L-Citrulline
	Pen	L-Penicillamine
	AcLys	L-N ^ε -Acetyllysine
30	hCys	L-Homo-cysteine
	hSer	L-Homo-serine

Particularly preferred residues for **group I** are

(EA)G	N-(2-Aminoethyl)glycine
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	(PrA)G	N-(3-Amino-n-propyl)glycine
	(BA)G	N-(4-Amino-n-butyl)glycine
	(PeA)G	N-(5-Amino-n-pentyl)glycine
	(EGU)G	N-(2-Guanidinoethyl)glycine
5	(PrGU)G	N-(3-Guanidino-n-propyl)glycine
	(BGU)G	N-(4-Guanidino-n-butyl)glycine
	(PeGU)G	N-(5-Guanidino-n-pentyl)glycine
	(PEG ₃ -NH ₂)G	N-[(CH ₂) ₃ O-(CH ₂ -CH ₂ O) ₂ -(CH ₂) ₃ -NH ₂]glycine

10

As mentioned earlier, the peptidic chains Z and Z¹ within the β -hairpin mimetics of the invention comprise 4 and, respectively, 6 residues or 5 and, respectively, 7 residues. The positions P¹ to Pⁿ and P^{1'} to P^{n'} of each amino acid residue in the chain Z and, respectively, Z¹ are unequivocally defined as follows: P¹ represents the first amino acid in the chain Z that is coupled with its C-terminus to the N-terminus of the templates (b)-(p) or of group -B-CO- in templates (a1), (a3) or (a4) or of group -A-CO- in template (a2), and Pⁿ represents the last amino acid in the chain Z; P^{1'} represents the first amino acid in the chain Z¹ that is coupled with its N-terminus to the C-terminus of the corresponding templates (b)-(p) or of group -B-CO- in template (a1), (a3) or (a4) or of group -A-CO- in template (a2), and P^{n'} represents the last amino acid in the chain Z¹.

20

Each of the positions P¹ to Pⁿ or P^{1'} to P^{n'} will preferably contain an amino acid residue belonging to one or two or three of the above types C, D, E, F I, or being Pro or Gly, as follows:

25

If n is 4 and n' is 6, the amino acid residues in positions 1 to 4 of Z and the amino acid residues in positions 1' to 6' of Z¹ are preferably:

- P1: of type D or of type E or of type F, or the residue is Pro;
- 30 - P2: of type E or of type F;
- P3: of type F, or the residue is Pro;
- P4: of type E;

- P1': of type E or of type F, or the residue is Gly;
- P2': of type D;
- P3': of type F or the residue is Pro;
- P4': of type D;
- 5 - P5': of type E, or of type F or the residue is Pro; and
- P6': of type E or of type F, or the residue is Pro; or
- P3 and P3', taken together, can form a group of type H.

10 If n is 5 and n' is 7, the amino acid residues in positions 1 to 5 of Z and the amino acid residues in positions 1' to 7' of Z¹ are preferably:

- P1: of type D or of type E or of type F, or the residue is Pro;
 - P2: of type E or of type F;
 - 15 - P3: of type F, or the residue is Pro;
 - P4: of type F;
 - P5: of type E
 - P1': of type D or of type E or of type F, or the residue is Pro;
 - 20 - P2': of type F;
 - P3': of type D or the residue is Pro;
 - P4': of type F;
 - P5': of type D, or the residue is Pro;
 - P6': of type E or of type F, or the residue is Pro; and
 - 25 - P7': of type E or of type I, or the residue is Gly; or
 - P2 and P2' and/or P4 and P4', taken together, can form a group of type H;
- at P7' also D-isomers being possible.

30 If n is 4 and n' is 6, the amino acid residues in positions 1 to 4 of Z and the amino acid residues in positions 1' to 6' of Z¹ are most preferably:

- P1: Tyr, Arg;
- P2: Cit, Arg;
- P3: Cys;

- P4: Arg-NH₂;
- P1': Lys, Arg;
- P2': Tyr;
- P3': Cys;
- 5 - P4': 2-Nal;
- P5': Arg; and
- P6': Arg.

Cys at pos P3 and P3' form a disulfide bridge

10 If n is 5 and n' is 7, the amino acid residues in positions 1 to 5 of Z and the amino acid residues in positions 1' to 7' of Z' are most preferably:

- P1: Tyr;
- P2: Arg;
- P3: Cit;
- 15 - P4: Cys;
- P5: Arg; Arg-NH₂;
- P1': Lys;
- P2': Cit;
- P3': Tyr;
- 20 - P4': Cys;
- P5': 2-Nal, Trp, F(pNH₂), W(6-Cl);
- P6': Arg; and
- P7': ^DArg, Arg, Ac-Arg, iPr-Arg, (EA)G, (PrA)G, (BA)G, (EGU)G, (PrGU)G, (BGU)G.

25 Cys at pos 4 and pos 4' form a disulfide bridge

Particularly preferred β -peptidomimetics of the invention include those described in Examples 6, 7, 8, 10, 12, 15, 20, 21, 22.

30 The process of the invention can advantageously be carried out as parallel array synthesis to yield libraries of template-fixed β -hairpin peptidomimetics of the above general formula I. Such parallel synthesis allows one to obtain arrays of numerous (normally 24 to 192, typically 96) compounds of general formula I in high yields and defined purities, minimizing the

formation of dimeric and polymeric by-products. The proper choice of the functionalized solid-support (i.e. solid support plus linker molecule), and the templates play thereby key roles.

The functionalized solid support is conveniently derived from polystyrene crosslinked with, preferably 1-5%, divinylbenzene; polystyrene coated with polyethyleneglycol spacers (Tentagel[®]); and polyacrylamide resins (see also Obrecht, D.; Villalgordo, J.-M, "Solid-Supported Combinatorial and Parallel Synthesis of Small-Molecular-Weight Compound Libraries", *Tetrahedron Organic Chemistry Series*, Vol. 17, Pergamon, Elsevier Science, 1998).

The solid support is functionalized by means of a linker, i.e. a bifunctional spacer molecule which contains on one end an anchoring group for attachment to the solid support and on the other end a selectively cleavable functional group used for the subsequent chemical transformations and cleavage procedures. For the purposes of the present invention two types of linkers are used:

Type 1 linkers are designed to release the amide group under acid conditions (Rink H, *Tetrahedron Lett.* **1987**, 28, 3783-3790). Linkers of this kind form amides of the carboxyl group of the amino acids; examples of resins functionalized by such linker structures include 4-[[[(2,4-dimethoxyphenyl)Fmoc-aminomethyl)phenoxyacetamido) aminomethyl] PS resin, 4-[[[(2,4-dimethoxyphenyl)Fmoc-aminomethyl)phenoxyacetamido) aminomethyl] -4-methylbenzhydrylamine PS resin (Rink amide MBHA PS Resin), and 4-[[[(2,4-dimethoxyphenyl)Fmoc-aminomethyl)phenoxyacetamido) aminomethyl] benzhydrylamine PS-resin (Rink amide BHA PS resin). Preferably, the support is derived from polystyrene crosslinked with, most preferably 1-5%, divinylbenzene and functionalized by means of the 4-[[[(2,4-dimethoxyphenyl)Fmoc-aminomethyl)phenoxyacetamido) linker.

Type 2 linkers are designed to eventually release the carboxyl group under acidic conditions. Linkers of this kind form acid-labile esters with the carboxyl group of the amino acids, usually acid-labile benzyl, benzhydryl and trityl esters; examples of such linker structures include 2-methoxy-4-hydroxymethylphenoxy (Sasrin[®] linker), 4-(2,4-dimethoxyphenyl-hydroxymethyl)-phenoxy (Rink linker), 4-(4-hydroxymethyl-3-methoxyphenoxy)butyric acid (HMPB linker),

trityl and 2-chlorotrityl. Preferably, the support is derived from polystyrene crosslinked with, most preferably 1-5%, divinylbenzene and functionalized by means of the 2-chlorotrityl linker.

When carried out as a parallel array synthesis the process of the invention can be

5 advantageously carried out as described hereinbelow but it will be immediately apparent to those skilled in the art how these procedures will have to be modified in case it is desired to synthesize one single compound of the above formula I

10 A number of reaction vessels (normally 24 to 192, typically 96) equal to the total number of compounds to be synthesized by the parallel method are loaded with 25 to 1000 mg, preferably 100 mg, of the appropriate functionalized solid support, preferably 1 to 3% cross linked polystyrene.

15 The solvent to be used must be capable of swelling the resin and includes, but is not limited to, dichloromethane (DCM), dimethylformamide (DMF), N-methylpyrrolidone (NMP), dioxane, toluene, tetrahydrofuran (THF), ethanol (EtOH), trifluoroethanol (TFE), isopropylalcohol and the like. Solvent mixtures containing as at least one component a polar solvent (e. g. 20% TFE/DCM, 35% THF/NMP) are beneficial for ensuring high reactivity and solvation of the resin-bound peptide chains (Fields, G. B., Fields, C. G., *J. Am. Chem. Soc.* **1991**, *113*, 4202-
20 4207).

Both the Rink linker that releases the C-terminal carboxylic amide group under acidic conditions and the 2-chlorotrityl linker that releases the C-terminal carboxylic acid group under acidic conditions, are stable to Fmoc deprotection conditions during the peptide synthesis.

25

The simultaneous release of the side chain protecting groups of the peptide fragment and the release of the peptide from the resin type 1 and type 2 is performed with 95% TFA and dichloromethane and scavengers such as phenol or triisopropylsilane (Bernatowicz, S.B. et al, *Tetrahedron Lett.*, **1989**, *30*, 4645-4648).

30

Suitable protecting groups for amino acids and, respectively, for their residues are, for example,

- for the amino group (as is present e. g. also in the side-chain of lysine)
Cbz benzyloxycarbonyl

	Boc	tert.-butoxycarbonyl
	Fmoc	9-fluorenylmethoxycarbonyl
	Alloc	allyloxycarbonyl
	Teoc	trimethylsilylethoxycarbonyl
5	Tcc	trichloroethoxycarbonyl
	Nps	o-nitrophenylsulfonyl;
	Trt	triphenylmethyl or trityl

- for the carboxyl group (as is present e. g. also in the side-chain of aspartic and glutamic
10 acid) by conversion into esters with the alcohol components

	tBu	tert.-butyl
	Bn	benzyl
	Me	methyl
15	Ph	phenyl
	Pac	Phenacyl
		Allyl
	Tse	trimethylsilylethyl
	Tce	trichloroethyl;

20

- for the guanidino group (as is present e. g. in the side-chain of arginine)

	Pmc	2,2,5,7,8-pentamethylchroman-6-sulfonyl
	Ts	tosyl (i. e. p-toluenesulfonyl)
25	Cbz	benzyloxycarbonyl
	Pbf	pentamethyldihydrobenzofuran-5-sulfonyl

- for the hydroxy group (as is present e. g. in the side-chain of threonine and serine)

30	tBu	tert.-butyl
	Bn	benzyl
	Trt	trityl

- and for the mercapto group (as is present e. g. in the side-chain of cysteine)

	Acm	acetamidomethyl
	tBu	tert.-butyl
	Bn	benzyl
	Trt	trityl
5	Mtr	4-methoxytrityl.

The 9-fluorenylmethoxycarbonyl- (Fmoc)-protected amino acid derivatives are preferably used as the building blocks for the construction of the template-fixed β -hairpin loop mimetics of formula I. For the deprotection, i. e. cleaving off of the Fmoc group, 20% piperidine in DMF or
10 2% DBU/2% piperidine in DMF can be used.

N-substituted glycine derivatives (type I) used as building blocks for the construction of certain compounds of formula I are derived from 9-fluorenylmethoxycarbonyl- (Fmoc)-protected amino acid derivatives or alternatively built up in two steps from leaving group-containing
15 glycine precursors, such as bromo, chloro or iodo acetic acid, and suitable primary amine building blocks $\text{NH}_2\text{-R}^{86}$. The first synthesis step consists of the attachment of the leaving group-containing acetylating agent, such as bromo acetic acid, to the resin bound intermediate through formation of the amide bond. The second reaction step - the nucleophilic displacement - is accomplished using the primary amine building blocks, wherein the residues are, if
20 necessary, suitably protected with groups as described above for side chains of amino acids.

The quantity of the reactant, i. e. of the amino acid derivative, is usually 1 to 20 equivalents based on the milliequivalents per gram (meq/g) loading of the functionalized solid support (typically 0.1 to 2.85 meq/g for polystyrene resins) originally weighed into the reaction tube.
25 Additional equivalents of reactants can be used if required to drive the reaction to completion in a reasonable time. The reaction tubes, in combination with the holder block and the manifold, are reinserted into the reservoir block and the apparatus is fastened together. Gas flow through the manifold is initiated to provide a controlled environment, for example, nitrogen, argon, air and the like. The gas flow may also be heated or chilled prior to flow
30 through the manifold. Heating or cooling of the reaction wells is achieved by heating the reaction block or cooling externally with isopropanol/dry ice and the like to bring about the desired synthetic reactions. Agitation is achieved by shaking or magnetic stirring (within the reaction tube). The preferred workstations (without, however, being limited thereto) are Labsource's Combi-chem station and MultiSyn Tech's-Syro synthesizer.

Amide bond formation requires the activation of the α -carboxyl group for the acylation step. When this activation is being carried out by means of the commonly used carbodiimides such as dicyclohexylcarbodiimide (DCC, Sheehan & Hess, *J. Am. Chem. Soc.* **1955**, 77, 1067-1068) or diisopropylcarbodiimide (DIC, Sarantakis et al *Biochem. Biophys. Res. Commun.* **1976**, 73, 336-342), the resulting dicyclohexylurea is insoluble and, respectively, diisopropylurea is soluble in the solvents generally used. In a variation of the carbodiimide method 1-hydroxybenzotriazole (HOBt, König & Geiger, *Chem. Ber* **1970**, 103, 788-798) is included as an additive to the coupling mixture. HOBt prevents dehydration, suppresses racemization of the activated amino acids and acts as a catalyst to improve the sluggish coupling reactions. Certain phosphonium reagents have been used as direct coupling reagents, such as benzotriazol-1-yl-oxy-tris-(dimethylamino)-phosphonium hexafluorophosphate (BOP) (Castro et al., *Tetrahedron Lett.* **1975**, 14, 1219-1222; *Synthesis*, **1976**, 751-752), or benzotriazol-1-yl-oxy-tris-pyrrolidino-phosphonium hexafluorophosphate (Py-BOP, Coste et al., *Tetrahedron Lett.* **1990**, 31, 205-208), or 2-(1H-benzotriazol-1-yl)-1,1,3,3-tetramethyluronium tetrafluoroborate (TBTU), or hexafluorophosphate (HBTU, Knorr et al., *Tetrahedron Lett.* **1989**, 30, 1927-1930); these phosphonium reagents are also suitable for in situ formation of HOBt esters with the protected amino acid derivatives. More recently diphenoxyposphoryl azide (DPPA) or O-(7-aza-benzotriazol-1-yl)-N,N,N',N'-tetramethyluronium tetrafluoroborate (TATU) or O-(7-aza-benzotriazol-1-yl)-N,N,N',N'-tetramethyluronium hexafluorophosphate (HATU)/7-aza-1-hydroxy benzotriazole (HOAt, Carpino et al., *Tetrahedron Lett.* **1994**, 35, 2279-2281) have also been used as coupling reagents.

Due to the fact that near-quantitative coupling reactions are essential it is desirable to have experimental evidence for completion of the reactions. The ninhydrin test (Kaiser et al., *Anal. Biochemistry* **1970**, 34, 595), where a positive colorimetric response to an aliquot of resin-bound peptide indicates qualitatively the presence of the primary amine, can easily and quickly be performed after each coupling step. Fmoc chemistry allows the spectrophotometric detection of the Fmoc chromophore when it is released with the base (Meienhofer et al., *Int. J. Peptide Protein Res.* **1979**, 13, 35-42).

The resin-bound intermediate within each reaction tube is washed free of excess of retained reagents, of solvents, and of by-products by repetitive exposure to pure solvent(s) by one of the two following methods:

- 1) The reaction wells are filled with solvent (preferably 5 ml), the reaction tubes, in combination with the holder block and manifold, are immersed and agitated for 5 to 300 minutes, preferably 15 minutes, and drained by gravity followed by gas pressure applied through the manifold inlet (while closing the outlet) to expel the solvent;
- 2) The manifold is removed from the holder block, aliquots of solvent (preferably 5 ml) are dispensed through the top of the reaction tubes and drained by gravity through a filter into a receiving vessel such as a test tube or vial.
- Both of the above washing procedures are repeated up to about 50 times (preferably about 10 times), monitoring the efficiency of reagent, solvent, and byproduct removal by methods such as TLC, GC, or inspection of the washings.
- The above described procedure of reacting the resin-bound compound with reagents within the reaction wells followed by removal of excess reagents, by-products, and solvents is repeated with each successive transformation until the final resin-bound fully protected linear peptide has been obtained.
- Before this fully protected linear peptide is detached from the solid support, it is possible, if desired, to selectively deprotect one or several protected functional group(s) present in the molecule and to appropriately substitute the reactive group(s) thus liberated. To this effect, the functional group(s) in question must initially be protected by a protecting group which can be selectively removed without affecting the remaining protecting groups present. Alloc (allyloxycarbonyl) is an example for such a protecting group for amino which can be selectively removed, e.g. by means of Pd^0 and phenylsilane in CH_2Cl_2 , without affecting the remaining protecting groups, such as Fmoc, present in the molecule. The reactive group thus liberated can then be treated with an agent suitable for introducing the desired substituent. Thus, for example, an amino group can be acylated by means of an acylating agent corresponding to the acyl substituent to be introduced.

Before detaching the peptide from the resin and removing the protecting groups from the fully protected peptide, it is also possible, if desired, to cyclize the linear peptide by forming an

interstrand linkage between side-chains of appropriate amino acid residues at opposite positions of the β -strand region.

5 Interstrand linkages and their formation have been discussed above, in connection with the explanations made regarding groups of the type H which can, for example, be disulfide bridges formed by cysteines and homocysteines at opposite positions of the β -strand, or glutamic and aspartic acid residues linking ornithines and, respectively, lysines located at opposite β -strand positions by amide bond formation. The formation of such interstrand linkages can be effected by methods well known in the art. For the formation of disulfide bridges preferably a solution
10 of 10 equivalents of iodine solution in DMF is applied for 1.5 h. The procedure is repeated for another 3h after with a fresh solution after filtering of the iodine solution.

Detachment and complete deprotection of the fully protected peptide from the solid support is achieved by immersion of the reaction tubes, in combination with the holder block and
15 manifold, in reaction wells containing a solution of the cleavage reagent (preferably 3 to 5 ml). Gas flow, temperature control, agitation, and reaction monitoring are implemented as described above and as desired to effect the detachment reaction. The reaction tubes, in combination with the holder block and manifold, are disassembled from the reservoir block and raised above the solution level but below the upper lip of the reaction wells, and gas pressure is applied through
20 the manifold inlet (while closing the outlet) to efficiently expel the final product solution into the reservoir wells. The resin remaining in the reaction tubes is then washed 2 to 5 times as above with 3 to 5 ml of an appropriate solvent to extract (wash out) as much of the detached product as possible. The product solutions thus obtained are combined, taking care to avoid cross-mixing. The individual solutions/extracts are then manipulated as needed to isolate the
25 final compounds. Typical manipulations include, but are not limited to, evaporation, concentration, liquid/liquid extraction, acidification, basification, neutralization or additional reactions in solution.

Alternatively the detachment and complete deprotection of the fully protected peptide from the
30 solid support is achieved manually in glass vessels.

The fully protected peptide derivative of type I is treated with 95% TFA, 2.5% H₂O, 2.5% TIS or another combination of scavengers for effecting the cleavage of protecting groups. The cleavage reaction time is commonly 30 minutes to 12 hours, preferably about 3.5 hours. The

resin is filtered and the cleavage solution containing the peptide is evaporated. The product is dissolved in an acid and water and extracted with isopropyl ether or other solvents which are suitable therefor. After collecting the aqueous layer and optionally oxidizing bridges of type H (Cysteine) by passing air through the aqueous layer and careful removal of the solvent, the
5 cyclic peptide derivative obtained as end-product can be isolated. Depending on its purity, this peptide derivative can be used directly for biological assays, or it has to be further purified, for example by preparative HPLC.

As mentioned earlier, it is thereafter possible, if desired, to convert a fully deprotected product
10 thus obtained into a pharmaceutically acceptable salt or to convert a pharmaceutically acceptable, or unacceptable, salt thus obtained into the corresponding free compound of formula I or into a different, pharmaceutically acceptable, salt. Any of these operations can be carried out by methods well known in the art.

15 The template starting materials of formula II used in the processes of the invention, pre-starting materials therefor, and the preparation of these starting and pre-starting materials are described in International Application PCT/EP02/01711 of the same applicants, published as WO 02/070547 A1.

20 The starting materials of formula H_2NR^{86} are known or can be prepared by methods which are well known in the art.

The β -hairpin peptidomimetics of the invention can be used in a wide range of applications in order to prevent HIV infections in healthy individuals and to slow or halt viral progression in infected patients or to inhibit the growth of cancer cells or to treat inflammatory disorders.

25 The β -hairpin peptidomimetics may be administered per se or may be applied as an appropriate formulations together with carriers, diluents or excipients well known in the art.

30 When used to treat or prevent HIV infections or cancer the β -hairpin peptidomimetics can be administered singly, as mixtures of several β -hairpin peptidomimetics, in combination with other anti-HIV agents, or antimicrobial agents or anti cancer agents, or in combination with other pharmaceutically active agents. The β -hairpin peptidomimetics can be administered per se or as pharmaceutical compositions.

Pharmaceutical compositions comprising β -hairpin peptidomimetics of the invention may be manufactured by means of conventional mixing, dissolving, granulating, coated tablet-making, levigating, emulsifying, encapsulating, entrapping or lyophilizing processes. Pharmaceutical
5 compositions may be formulated in conventional manner using one or more physiologically acceptable carriers, diluents, excipients or auxiliaries which facilitate processing of the active β -hairpin peptidomimetics into preparations which can be used pharmaceutically. Proper formulation depends upon the method of administration chosen.

10 For topical administration the β -hairpin peptidomimetics of the invention may be formulated as solutions, gels, ointments, creams, suspensions, etc. as are well-known in the art.

Systemic formulations include those designed for administration by injection, e.g. subcutaneous, intravenous, intramuscular, intrathecal or intraperitoneal injection, as well as
15 those designed for transdermal, transmucosal, oral or pulmonary administration.

For injections, the β -hairpin peptidomimetics of the invention may be formulated in adequate solutions, preferably in physiologically compatible buffers such as Hink's solution, Ringer's solution, or physiological saline buffer. The solution may contain formulatory agents such as
20 suspending, stabilizing and/or dispersing agents. Alternatively, the β -hairpin peptidomimetics of the invention may be in powder form for combination with a suitable vehicle, e.g., sterile pyrogen-free water, before use.

For transmucosal administration, penetrants appropriate to the barrier to be permeated are used
25 in the formulation as known in the art.

For oral administration, the compounds can be readily formulated by combining the active β -hairpin peptidomimetics of the invention with pharmaceutically acceptable carriers well known in the art. Such carriers enable the β -hairpin peptidomimetics of the invention to be formulated
30 as tablets, pills, dragees, capsules, liquids, gels, syrups, slurries, suspensions etc., for oral ingestion of a patient to be treated. For oral formulations such as, for example, powders, capsules and tablets, suitable excipients include fillers such as sugars, such as lactose, sucrose, mannitol and sorbitol; cellulose preparations such as maize starch, wheat starch, rice starch,

potato starch, gelatin, gum tragacanth, methyl cellulose, hydroxypropylmethyl cellulose, sodium carboxymethylcellulose, and/or polyvinylpyrrolidone (PVP); granulating agents; and binding agents. If desired, disintegrating agents may be added, such as cross-linked polyvinylpyrrolidones, agar, or alginic acid or a salt thereof, such as sodium alginate. If
5 desired, solid dosage forms may be sugar-coated or enteric-coated using standard techniques.

For oral liquid preparations such as, for example, suspensions, elixirs and solutions, suitable carriers, excipients or diluents include water, glycols, oils, alcohols, etc. In addition, flavoring agents, preservatives, coloring agents and the like may be added.

10

For buccal administration, the composition may take the form of tablets, lozenges, etc. formulated as usual.

For administration by inhalation, the β -hairpin peptidomimetics of the invention are
15 conveniently delivered in form of an aerosol spray from pressurized packs or a nebulizer, with the use of a suitable propellant, e.g. dichlorodifluoromethane, trichlorofluoromethane, carbon dioxide or another suitable gas. In the case of a pressurized aerosol the dose unit may be determined by providing a valve to deliver a metered amount. Capsules and cartridges of e.g. gelatin for use in an inhaler or insufflator may be formulated containing a powder mix of the β -
20 hairpin peptidomimetics of the invention and a suitable powder base such as lactose or starch.

The compounds may also be formulated in rectal or vaginal compositions such as suppositories together with appropriate suppository bases such as cocoa butter or other glycerides.

25 In addition to the formulations described previously, the β -hairpin peptidomimetics of the invention may also be formulated as depot preparations. Such long acting formulations may be administered by implantation (e.g. subcutaneously or intramuscularly) or by intramuscular injection. For the manufacture of such depot preparations the β -hairpin peptidomimetics of the invention may be formulated with suitable polymeric or hydrophobic materials (e.g. as an
30 emulsion in an acceptable oil) or ion exchange resins, or as sparingly soluble salts.

In addition, other pharmaceutical delivery systems may be employed such as liposomes and emulsions well known in the art. Certain organic solvents such as dimethylsulfoxide also may

be employed. Additionally, the β -hairpin peptidomimetics of the invention may be delivered using a sustained-release system, such as semipermeable matrices of solid polymers containing the therapeutic agent. Various sustained-release materials have been established and are well known by those skilled in the art. Sustained-release capsules may, depending on their chemical
5 nature, release the compounds for a few weeks up to over 100 days. Depending on the chemical nature and the biological stability of the therapeutic agent, additional strategies for protein stabilization may be employed.

As the β -hairpin peptidomimetics of the invention may contain charged residues, they may be
10 included in any of the above-described formulations as such or as pharmaceutically acceptable salts. Pharmaceutically acceptable salts tend to be more soluble in aqueous and other protic solvents than are the corresponding free base forms.

The β -hairpin peptidomimetics of the invention, or compositions thereof, will generally be used
15 in an amount effective to achieve the intended purpose. It is to be understood that the amount used will depend on a particular application.

For topical administration to treat or prevent infections a therapeutically effective dose can be determined using, for example, the in vitro assays provided in the examples. The treatment may
20 be applied while the infection is visible, or even when it is not visible. An ordinary skilled expert will be able to determine therapeutically effective amounts to treat topical infections without undue experimentation.

For systemic administration, a therapeutically effective dose can be estimated initially from in
25 vitro assays. For example, a dose can be formulated in animal models to achieve a circulating β -hairpin peptidomimetic concentration range that includes the IC_{50} as determined in the cell culture (i.e. the concentration of a test compound that is lethal to 50% of a cell culture). Such information can be used to more accurately determine useful doses in humans.

30 Initial dosages can also be determined from in vivo data, e.g. animal models, using techniques that are well known in the art. One having ordinary skills in the art could readily optimize administration to humans based on animal data.

Dosage amount for applications as anti-HIV agents may be adjusted individually to provide plasma levels of the β -hairpin peptidomimetics of the invention which are sufficient to maintain the therapeutic effect. Therapeutically effective serum levels may be achieved by administering multiple doses each day.

5

In cases of local administration or selective uptake, the effective local concentration of the β -hairpin peptidomimetics of the invention may not be related to plasma concentration. One having the skills in the art will be able to optimize therapeutically effective local dosages without undue experimentation.

10

The amount of β -hairpin peptidomimetics administered will, of course, be dependent on the subject being treated, on the subject's weight, the severity of the affliction, the manner of administration and the judgement of the prescribing physician.

15

The anti-HIV therapy may be repeated intermittently while infections are detectable or even when they are not detectable. The therapy may be provided alone or in combination with other drugs, such as for example other anti-HIV agents or anti cancer agents, or anti inflammatory agents or other antimicrobial agents.

20

Normally, a therapeutically effective dose of the β -hairpin peptidomimetics described herein will provide therapeutic benefit without causing substantial toxicity.

25

Toxicity of the β -hairpin peptidomimetics of the invention herein can be determined by standard pharmaceutical procedures in cell cultures or experimental animals, e.g., by determining the LD₅₀ (the dose lethal to 50% of the population) or the LD₁₀₀ (the dose lethal to 100% of the population). The dose ratio between toxic and therapeutic effect is the therapeutic index. Compounds which exhibit high therapeutic indices are preferred. The data obtained from these cell culture assays and animal studies can be used in formulating a dosage range that is not toxic for use in humans. The dosage of the β -hairpin peptidomimetics of the invention lies preferably within a range of circulating concentrations that include the effective dose with little or no toxicity. The dosage may vary within the range depending upon the dosage form employed and the route of administration utilized. The exact formulation, route of administration and dose can be chosen by the individual physician in view of the patient's

30

condition (see, e.g. Fingl et al. 1975, In : *The Pharmacological Basis of Therapeutics*, Ch.1, p.1).

The following Examples illustrate the invention in more detail but are not intended to limit its scope in any way. The following abbreviations are used in these Examples:

HBTU: 1-benzotriazol-1-yl-tetramethyluronium hexafluorophosphate (Knorr et al. *Tetrahedron Lett.* 1989, 30, 1927-1930);

HOBt: 1-hydroxybenzotriazole;

DIEA: diisopropylethylamine;

10 DIC: diisopropylcarbodiimide;

HOAT: 7-aza-1-hydroxybenzotriazole;

HATU: O-(7-aza-benzotriazole-1-yl)-N,N,N',N'-tetramethyluronium hexafluorophosphate (Carpino et al. *Tetrahedron Lett.* 1994, 35, 2279-2281).

15 Examples

1. Peptide synthesis

Coupling of the first protected amino acid residue to the resin

20

The synthesis was carried out using a ACT 90 synthesizer (Advanced Chemtec)

A) Preparation of preloaded Rink amide resin:

11 g 1% DVB- Aminomethyl-PS (loading 1.14 mmol/g) from Rapp Polymer GmbH,
25 Germany (H1020, no. 100/0002) was allowed to swell in CH₂Cl₂ (100 ml) for 12 h, the solvent was filtered off and the resin was suspended in DMF (100 ml) for 30 min. After filtering off DMF, a solution of 1.2 eq p-((R,S)- α -[1-(9H-Fluoren-9-yl)-methoxyformamido]-2,4-dimethoxybenzyl)-phenoxyacetic acid (Fmoc Rink linker, Novabiochem, Switzerland), 1.2 eq HOBt and 1.2 eq. DIC in 50 ml DMF was given to
30 the resin and shaken at 25°C for 12h. The solution was filtered off and the resin was washed with DMF (3x) and CH₂Cl₂ (3x). The resin was dried under vacuum for 12 hours.

The Fmoc-group was removed by treatment with a solution of 40% piperidine in DMF (191 ml) for 45 min at 25°C, the resin was washed DMF (1x), and the treatment was repeated. The resin was washed with DMF (1 x) and CH₂Cl₂ (1x) and dried under vacuum for 12 hours. Loading was typically 0.7-0.85 mMol/g.

5

1.0 g of Rink amide resin (0.85 mMol/g, 0.85 mmol) was filled into a dried flask. The resin was suspended in CH₂Cl₂ (50 ml) and allowed to swell at room temperature under constant stirring for 60 min, the solvent was filtered off and the resin was suspended in DMF (50 ml) for 5 hours. After filtering off the solvent, the resin was treated with 5eq of the first suitably protected amino acid residue (see below), 5eq HOBT, and 5eq DIC in DMF (40 ml), the mixture was shaken at 25°C for 12 hours. The resin then was washed in the following order with CH₂Cl₂ (1x), DMF (1x), CH₂Cl₂ (1x) and dried under vacuum for 5 hours. Loading was typically 0.4-0.55 mMol/g.

15 The following preloaded resin was prepared: Fmoc-Arg(Pbf)-NH-Rink amide resin.

B) Preparation of preloaded chlorotrityl resin

0.5 g of 2-chlorotritylchloride resin (Barlos et al. *Tetrahedron Lett.* 1989, 30, 3943-3946) (0.83 mMol/g, 0.415 mmol) was filled into a dried flask. The resin was suspended in CH₂Cl₂ (2.5 ml) and allowed to swell at room temperature under constant stirring for 30 min. The resin was treated with 0.415 mMol (1eq) of the first suitably protected amino acid residue (see below) and 284 µl (4eq) of diisopropylethylamine (DIEA) in CH₂Cl₂ (2.5 ml), the mixture was shaken at 25°C for 4 hours. The resin colour changed to purple and the solution remained yellowish. The resin was shaken (CH₂Cl₂ /MeOH/DIEA : 17/2/1), 30 ml for 30 min; then washed in the following order with CH₂Cl₂ (1x), DMF (1x), CH₂Cl₂ (1x), MeOH (1x), CH₂Cl₂(1x), MeOH (1x), CH₂Cl₂ (2x), Et₂O (2x) and dried under vacuum for 6 hours. Loading was typically 0.6-0.7 mMol/g.

The following preloaded resin was prepared: Fmoc-Arg(Pbf)O-chlorotritylresin.

30

Synthesis of the fully protected peptide fragment

The synthesis was carried out using a Syro-peptide synthesizer (Multisyn tech) using 24
 5 to 96 reaction vessels. In each vessel was placed 60 mg (weight of the resin before loading) of the above resin. The following reaction cycles were programmed and carried out:

	Step	Reagent	Time
10	1	CH ₂ Cl ₂ , wash and swell (manual)	3 x 1 min.
	2	DMF, wash and swell	1 x 5 min
	3	20 % piperidine/DMF	1 x 5 min.
	4	DMF, wash	5 x 2 min.
	5	5 equiv. Fmoc amino acid/DMF/NMP 2/1	
15		+ 5 eq. HBTU	
		+ 5 eq. HOBt	
		+ 5 eq. DIEA	1 x 120 min.
	6	DMF, wash	4 x 2 min.
	7	CH ₂ Cl ₂ , wash (at the end of the synthesis)	3 x 2 min.
20			

Steps 3 to 6 are repeated to add each amino-acid.

Formation of disulfide bridge (interstrand linkage)

0.05 mmol of peptide-carrying resin was swelled in 3 mL of dry DCM for 1 h and after filtering
 25 off the DCM, with dry DMF (3 mL) for overnight. Then 10 equivalents of iodine solution in DMF (6 mL) was added to the reactor and stirred for 1.5 h. The resin was filtered and the fresh solution of iodine (10 equivalents) in DMF (6 mL) was added and stirred for another 3 h. The resin was filtered and washed thoroughly several times with DMF and DCM.

Cleavage and deprotection of the fully protected peptide fragment

Cleavage from the resin and full deprotection of the peptide were done by 7.5 mL of the cleavage mixture TFA:TIS:H₂O (95:2.5:2.5) for 3.5 h. The resin was filtered and the cleaved peptide was collected in a tube and evaporated to dryness under vacuum. The crude peptide

was dissolved in 20% AcOH in water (7 mL) and extracted with isopropyl ether (4 mL) for three times. The aqueous layer was collected and evaporated to dryness. For final oxidation of the cysteine (for formation of disulfide bridge), air was passed through the diluted solution of crude peptide in H₂O (6 mL) for 12 h.

5

Purification of the end-product:

The water phase was dried under vacuum and then the product purified by preparative reverse phase HPLC.

- 10 The products were analysed by ESI-MS and after lyophilisation the products were obtained as a white powder. The analytical data comprising HPLC retention times and ESI-MS are shown in table 1 and table 2.

- 15 Analytical HPLC retention times (RT, in minutes) were determined using a VYDAC 218MS5215 column with the following solvents A (H₂O + 0.02% TFA) and B (CH₃CN) and the gradient: 0 min: 92%A, 8%B; 8 min: 62%A 38%B; 9-12 min: 0% A, 100%B.

- 20 **Examples 1-3** (n = 4, n' = 6) are shown in *table 1*. The peptides were synthesized starting with the amino acid Arg which was grafted to the resin. Starting resin was Fmoc-Arg(Pbf)-Rink-amide resin, which was prepared as described above. The linear peptides were synthesized on solid support according to procedure described above in the following sequence: Resin-P4-P3-P2-P1-^LPro-^DLys-P1'-P2'-P3'-P4'-P5'-P6'; disulfide bridge formation, cleavage from the resin, deprotection and purification were effected as indicated.
- HPLC-retention times (minutes) were determined using the *gradient* described above.

25

- Examples 4 and 5** (n = 4, n' = 6) are shown in *table 1*. The peptides were synthesized starting with the amino acid Arg which was grafted to the resin. Starting resin was Fmoc-Arg(Pbf)-Rink-amide resin, which was prepared as described above. The linear peptides were synthesized on solid support according to procedure described above in the following
- 30 sequence: Resin-P4-P3-P2-P1-^LPro-^DPro-P1'-P2'-P3'-P4'-P5'-P6'; disulfide bridge formation, cleavage from the resin, deprotection and purification were effected as indicated.
- HPLC-retention times (minutes) were determined using the *gradient* described above.

Example 6 ($n = 4$, $n' = 6$) is shown in *table 1*. The peptide was synthesized starting with the amino acid Arg which was grafted to the resin. Starting resin was Fmoc-Arg(Pbf)-Rink-amide resin, which was prepared as described above. The linear peptide was synthesized on solid support according to procedure described above in the following sequence: Resin-P4-P3-P2-P1-¹Pro-¹Lys-P1'-P2'-P3'-P4'-P5'-P6'; disulfide bridge formation, cleavage from the resin, deprotection and purification were effected as indicated.

HPLC-retention time (minutes) was determined using the *gradient* described above.

Example 7 and 10-19 ($n = 5$, $n' = 7$) are shown in *table 2*. The peptides were synthesized starting with the amino acid Arg which was grafted to the resin. Starting resin was Fmoc-Arg(Pbf)-Rink-amide resin, which was prepared as described above. The linear peptides were synthesized on solid support according to procedure described above in the following sequence: Resin-P5-P4-P3-P2-P1-¹Pro-^DPro-P1'-P2'-P3'-P4'-P5'-P6'-P7'; disulfide bridge formation, cleavage from the resin, deprotection and purification were effected as indicated.

HPLC-retention times (minutes) were determined using the *gradient* described above: Ex. 7 (4.27), Ex. 10 (4.13), Ex. 11 (3.68), Ex. 12 (2.28), Ex. 13 (4.13), Ex. 14 (5.96), Ex. 15 (5.76), Ex. 16 (5.82), Ex. 17 (5.90), Ex. 18 (5.90), Ex. 19 (5.84).

Example 8 ($n = 5$, $n' = 7$) is shown in *table 2*. The peptide was synthesized starting with the amino acid Arg which was grafted to the resin. Starting resin was Fmoc-Arg(Pbf)-Rink-amide resin, which was prepared as described above. The linear peptide was synthesized on solid support according to procedure described above in the following sequence: Resin-P5-P4-P3-P2-P1-¹Pro-^DPro-P1'-P2'-P3'-P4'-P5'-P6'-P7', and the disulfide bridge was formed.

The resin was then swelled in dry DCM for 0.5 hrs. DCM was filtered off and 5 mL of dry DCM was added to the resin. 0.5 mL (2.92 mmol) of DIPEA and 0.125 mL (1.32 mmol) of acetic anhydride were added to the resin and stirred for 4 hrs. The resin was filtered and washed thoroughly with DCM, DMF, DCM, MeOH, Et₂O and dried in vacuum. The peptide was cleaved from the resin, deprotected and purified as indicated.

HPLC-retention time was determined using the *gradient* described above: 4.33 minutes.

Example 9 ($n = 5$, $n' = 7$) is shown in *table 2*. The peptide was synthesized starting with the amino acid Arg which was grafted to the resin. Starting resin was Fmoc-Arg(Pbf)-Rink-amide resin, which was prepared as described above. The linear peptide was synthesized on

solid support according to procedure described above in the following sequence: Resin-P5-P4-P3-P2-P1-^LPro-^DPro-P1'-P2'-P3'-P4'-P5'-P6'-P7' and the disulfide bridge was formed.

2.5 mL of dry THF and 200 µL of acetone was added to the reactor followed by addition of 2.5 mL of 50:50 (H₂O: Acetic acid) and stirred for 4 hrs. The solution of NaCNBH₃ (120 mg, 1.90 mmol) in THF (2 mL) was added to the reactor and stirred for 4 hrs. Then the solvent was filtered and washed with DCM, DMF, DCM, MeOH, Et₂O and dried in vacuum. The peptide was cleaved from the resin, deprotected and purified as indicated.

HPLC-retention times was determined using the *gradient* described above: 4.37 minutes.

Example 20 (n = 5, n' = 7) is shown in *table 2*. The peptide was synthesized starting with the amino acid Arg which was grafted to the resin. Starting resin was Fmoc-Arg(Pbf)-chlorotrityl resin, which was prepared as described above. The linear peptide was synthesized on solid support according to procedure described above in the following sequence: Resin-P5-P4-P3-P2-P1-^LPro-^DPro-P1'-P2'-P3'-P4'-P5'-P6'-P7'; disulfide bridge formation, cleavage from the resin, deprotection and purification were effected as indicated.

HPLC-retention time was determined using the *gradient* described above: 4.35 minutes.

Example 21 (n = 5, n' = 7) is shown in *table 2*. The peptide was synthesized starting with the amino acid Arg which was grafted to the resin. Starting resin was Fmoc-Arg(Pbf)-Rink-amide resin, which was prepared as described above. The linear peptide was synthesized on solid support according to procedure described above in the following sequence: Resin-P5-P4-P3-P2-P1-[(b1)-154*]-P1'-P2'-P3'-P4'-P5'-P6'-P7'; disulfide bridge formation, cleavage from the resin, deprotection and purification were effected as indicated.

HPLC-retention time was determined using the *gradient* described above: 4.02 minutes.

* Template [(b1)-154] is (2S,6S,9S)-6-amino-2-carboxymethyl-3,8-diazabicyclo-[4,3,0]-nonane-1,4-dione

Example 22 (n = 5, n' = 7) is shown in *table 2*. The peptide was synthesized starting with the amino acid Arg which was grafted to the resin. Starting resin was Fmoc-Arg(Pbf)-Rink-amide resin, which was prepared as described above. The linear peptide was synthesized on solid support according to procedure described above in the following sequence: Resin-P5-P4-P3-P2-P1-AMPA-P1'-P2'-P3'-P4'-P5'-P6'-P7'; disulfide bridge formation, cleavage from the resin, deprotection and purification were effected as indicated.

HPLC-retention time was determined using the *gradient* described above: 4.62 minutes.

Example 23 ($n = 5$, $n' = 7$) is shown in *table 2*. The peptide was synthesized starting with the amino acid Arg which was grafted to the resin. Starting resin was Fmoc-Arg(Pbf)-Rink-amide resin, which was prepared as described above. The linear peptide was synthesized on solid support according to procedure described above in the following sequence: Resin-P5-P4-P3-P2-P1-^DPro-^LPro-P1'-P2'-P3'-P4'-P5'-P6'-P7'; disulfide bridge formation, cleavage from the resin, deprotection and purification were effected as indicated.

HPLC-retention time was determined using the *gradient* described above: 4.13, 4.40* minutes.

10 * The MS is showing the correct mass.

Example 24 ($n = 5$, $n' = 7$) is shown in *table 2*. The peptide was synthesized starting with the amino acid Arg which was grafted to the resin. Starting resin was Fmoc-Arg(Pbf)-Rink-amide resin, which was prepared as described above. The linear peptide was synthesized on solid support according to procedure described above in the following sequence: Resin-P5-P4-P3-P2-P1-^LPro-^LPro-P1'-P2'-P3'-P4'-P5'-P6'-P7'; disulfide bridge formation, cleavage from the resin, deprotection and purification were effected as indicated.

HPLC-retention time was determined using the *gradient* described above: 4.08 minutes.

Example 25 ($n = 5$, $n' = 7$) is shown in *table 2*. The peptide was synthesized starting with the amino acid Arg which was grafted to the resin. Starting resin was Fmoc-Arg(Pbf)-Rink-amide resin, which was prepared as described above. The linear peptide was synthesized on solid support according to procedure described above in the following sequence: Resin-P5-P4-P3-P2-P1-^LPro-^DPic-P1'-P2'-P3'-P4'-P5'-P6'-P7'; disulfide bridge formation, cleavage from the resin, deprotection and purification were effected as indicated.

25 HPLC-retention time was determined using the *gradient* described above: 4.47 minutes.

Table 1: Examples 1-6, n = 4, n' = 6

Example	Sequ.ID	P6'	P5'	P4'	P3'	P2'	P1'	Template	P1	P2	P3	P4	RT	Purity% ^{a)}	[M+ H]/2
1	SEQ ID NO:1	Arg	Arg	2-Nal	Cys	Tyr	Lys	D ⁺ Lys ⁺ Pro	Tyr	Cit	Cys	Arg-NH ₂	3.75	98	862.6
2	SEQ ID NO:2	Arg	Arg	2-Nal	Cys	Tyr	Lys	D ⁺ Lys ⁺ Pro	Tyr	Cit	Cys	Arg-NH ₂	3.87	96	876.3
3	SEQ ID NO:3	Arg	Arg	2-Nal	Cys	Tyr	Lys	D ⁺ Lys ⁺ Pro	Arg	Cit	Cys	Arg-NH ₂	3.28	97	858.4
4	SEQ ID NO:4	Arg	Arg	2-Nal	Cys	Tyr	Lys	D ⁺ Pro ⁺ Pro	Tyr	Arg	Cys	Arg-NH ₂	4.62	100	845.9
5	SEQ ID NO:5	Arg	Arg	2-Nal	Cys	Tyr	Arg	D ⁺ Pro ⁺ Pro	Tyr	Arg	Cys	Arg-NH ₂	4.83	98	860.0
6	SEQ ID NO:6	Arg	Arg	2-Nal	Cys	Tyr	Arg	L ⁺ Lys ⁺ Pro	Tyr	Cit	Cys	Arg-NH ₂	4.10	96	875.9

a) %-purity of compounds after prep. HPLC.
cysteines at position P3' and P3 are linked by a disulfide bridge

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Table 2: Examples 7-25, n = 6, n' = 7

Example	Seq. ID	P7'	P6'	P5'	P4'	P3'	P2'	P1'	Template	P1	P2	P3	P4	P5	Purity% ^{a)}	[M+ H] ²
7	SEQ ID NO:7	H-Arg	Arg	2-Nal Cys	Tyr	Cit	Lys	D ¹ Pro ¹ Pro	Tyr	Arg	Cit	Cys	Arg-NH ₂	88	1003.6	
8	SEQ ID NO:8	AcArg ^b	Arg	2-Nal Cys	Tyr	Cit	Lys	D ¹ Pro ¹ Pro	Tyr	Arg	Cit	Cys	Arg-NH ₂	100	1023.8	
9	SEQ ID NO:9	iPrArg ^c	Arg	2-Nal Cys	Tyr	Cit	Lys	D ¹ Pro ¹ Pro	Tyr	Arg	Cit	Cys	Arg-NH ₂	95	1025.1	
10	SEQ ID NO:10	H ^D -Arg	Arg	2-Nal Cys	Tyr	Cit	Lys	D ¹ Pro ¹ Pro	Tyr	Arg	Cit	Cys	Arg-NH ₂	98	1003.6	
11	SEQ ID NO:11	H-Arg	Arg	Trp Cys	Tyr	Cit	Lys	D ¹ Pro ¹ Pro	Tyr	Arg	Cit	Cys	Arg-NH ₂	100	997.4	
12	SEQ ID NO:12	H-Arg	Arg	F(pNH ₂)Cys	Tyr	Cit	Lys	D ¹ Pro ¹ Pro	Tyr	Arg	Cit	Cys	Arg-NH ₂	100	985.3	
13	SEQ ID NO:13	H-Arg	Arg	W(6-Cl)Cys	Tyr	Cit	Lys	D ¹ Pro ¹ Pro	Tyr	Arg	Cit	Cys	Arg-NH ₂	100	1015.3	
14	SEQ ID NO:14	H-(EA)G	Arg	2-Nal Cys	Tyr	Cit	Lys	D ¹ Pro ¹ Pro	Tyr	Arg	Cit	Cys	Arg-NH ₂	84	1010.3	
15	SEQ ID NO:15	H-(PrA)G	Arg	2-Nal Cys	Tyr	Cit	Lys	D ¹ Pro ¹ Pro	Tyr	Arg	Cit	Cys	Arg-NH ₂	100	982.0	
16	SEQ ID NO:16	H-(BA)G	Arg	2-Nal Cys	Tyr	Cit	Lys	D ¹ Pro ¹ Pro	Tyr	Arg	Cit	Cys	Arg-NH ₂	89	989	
17	SEQ ID NO:17	H-(EGU)G	Arg	2-Nal Cys	Tyr	Cit	Lys	D ¹ Pro ¹ Pro	Tyr	Arg	Cit	Cys	Arg-NH ₂	96	1003.0	
18	SEQ ID NO:18	H-(PrGU)G	Arg	2-Nal Cys	Tyr	Cit	Lys	D ¹ Pro ¹ Pro	Tyr	Arg	Cit	Cys	Arg-NH ₂	99	1009.9	
19	SEQ ID NO:19	H-(BGU)G	Arg	2-Nal Cys	Tyr	Cit	Lys	D ¹ Pro ¹ Pro	Tyr	Arg	Cit	Cys	Arg-NH ₂	86	989.0	
20	SEQ ID NO:20	H-Arg	Arg	2-Nal Cys	Tyr	Cit	Lys	D ¹ Pro ¹ Pro	Tyr	Arg	Cit	Cys	Arg-OH	100	1004.2	
21	SEQ ID NO:21	H-Arg	Arg	2-Nal Cys	Tyr	Cit	Lys	(b1)-154	Tyr	Arg	Cit	Cys	Arg-NH ₂	97	1011.1	
22	SEQ ID NO:22	H-Arg	Arg	2-Nal Cys	Tyr	Cit	Lys	AMPA	Tyr	Arg	Cit	Cys	Arg-NH ₂	100	979.3	
23	SEQ ID NO:23	H-Arg	Arg	2-Nal Cys	Tyr	Cit	Lys	L ¹ Pro ¹ Pro	Tyr	Arg	Cit	Cys	Arg-NH ₂	100	1002.9	
24	SEQ ID NO:24	H-Arg	Arg	2-Nal Cys	Tyr	Cit	Lys	L ¹ Pro ¹ Pro	Tyr	Arg	Cit	Cys	Arg-NH ₂	100	1002.9	
25	SEQ ID NO:25	H-Arg	Arg	2-Nal Cys	Tyr	Cit	Lys	D ¹ Pic ¹ Pro	Tyr	Arg	Cit	Cys	Arg-NH ₂	100	1010.1	

a) %-purity of compounds after prep. HPLC.

b) Ac: Acetyl

c) iPr: Isopropyl

cysteines at position P4' and P4 are linked by a disulfide bridge

(b1)-154 is (2S,6S,9S)-6-Amino-2-carboxymethyl-3,8-diazabicyclo-[4,3,0]-nonane-1,4-dione

2. Biological methods

2.1. Preparation of the peptides.

Lyophilized peptides were weighed on a Microbalance (Mettler MT5) and dissolved in sterile water to a final concentration of 1 mM unless stated otherwise. Stock solutions were kept at +4°C, light protected.

2.2. Ca^{2+} assay: CXCR4-antagonizing activity of the peptides.

3-4 Mio CXCR4 transfected pre-B cells [see references 1, 2 and 3, below] per measurement were resuspended in 200 μl MSB (20 mM 4-(2-Hydroxyethyl)-piperazin-1-ethansulfonic acid (HEPES), 136 mM NaCl, 4.8 mM KCl and 1 mM CaCl_2) containing 5 mM D-Glucose and were loaded with 0.75 μl of 1 mM Fura-2-acetoxymethylester for 17 minutes at 37°C. The cells were washed free from Fura-2-AM with a platelet centrifuge and resuspended in 800 μl MSB containing 5 mM D-Glucose. The peptides to be administered were diluted to a 100 fold end concentration in MSB/0.2 % PPL, and 8 μl were injected. $[\text{Ca}^{2+}]_i$ -dependent fluorescence change in response to single or sequential stimulation with the peptide was recorded with a fluorimeter at an excitation wavelength of 340 nm and an end emission wavelength of 510 nm [see ref. 4, below]. Measurements were done under continuous stirring at 37°C. The signal intensity was calibrated with 3 mM CaCl_2 /1 mM Ionomycin (maximal fura-2-acetoxymethylester saturation) and 10 μM MnCl_2 (minimal Fura-2-acetoxymethylester saturation) and $[\text{Ca}^{2+}]_i$ -changes are presented in % fura-2-acetoxymethylester saturation. The rate of $[\text{Ca}^{2+}]_i$ -changes was calculated on the basis of the initial $[\text{Ca}^{2+}]_i$ -changes and plotted in dependence of chemokine concentration to obtain a sigmoidal curve and to determine the IC_{50} values.

MSB: 20 mM HEPES, 136 mM NaCl, 4.8 mM KCl, 1 mM $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$, pH 7.4; Osmolarity: 310 mOsm adjusted with NaOH or HCl, adjusted with dH₂O or PBS.

MSB plus: 5 mM D-glucose in MSB (50 mg/50mL).

Fura 2-acetoxymethylester: 1 mM stock solution in dimethylsulfoxide.

2.3. FIGS-AssayTM

The assay was performed according to ref. 5, below. Stock dilutions of the peptides (10 mM) were prepared by dissolving in 10 mM Tris-HCl at room temperature. Stock solutions were

kept at + 4°C, light protected. Working dilutions were prepared extemporaneously by serial dilution in Phosphate Buffered Saline (PBS) and added in a final volume of 10 µL directly to the cell cultures. After 48 hours of co-cultivation the cultures were rinsed with PBS and then exposed to glutaraldehyde/ formaldehyde (0.2 % / 2 %) in PBS for five minutes. For photometric quantification the fixed cultures were subsequently incubated with ortho-nitro-phenyl-galactopyranoside (ONPG) as a β-galactosidase substrate, which was enzymatically converted into the chromophore ortho-nitrophenol (ONP). The read out is directly obtained by measuring optical density of wells at 405 nm in an iEMS 96well-plate reader.

2.4. Cytotoxicity assay

The cytotoxicity of the peptides to HELA cells (Acc57) and COS-7 cells (CRL-1651) was determined using the MTT reduction assay [see ref. 6 and 7, below]. Briefly the method was as follows: HELA cells and COS-7 cells were seeded at $7.0 \cdot 10^3$ and, respectively, $4.5 \cdot 10^3$ cells per well and grown in 96-well microtiter plates for 24 hours at 37°C at 5% CO₂. At this point, time zero (Tz) was determined by MTT reduction (see below). The supernatant of the remaining wells was discarded and fresh medium and the peptides in serial dilutions of 12.5, 25 and 50 µM were pipeted into the wells. Each peptide concentration was assayed in triplicate. Incubation of the cells was continued for 48 hours at 37°C at 5% CO₂. Wells were then washed once with PBS and subsequently 100 µl MTT reagent (0.5 mg/mL in medium RPMI1640 and, respectively, DMEM) was added to the wells. This was incubated at 37°C for 2 hours and subsequently the medium was aspirated and 100 µl isopropanol was added to each well. The absorbance at 595 nm of the solubilized product was measured (OD₅₉₅peptide). For each concentration averages were calculated from triplicates. The percentage of growth was calculated as follows: $(OD_{595} \text{ peptide} - OD_{595} \text{ Tz} - OD_{595} \text{ Empty well}) / (OD_{595} \text{ Tz} - OD_{595} \text{ Empty well}) \times 100\%$ and was plotted for each peptide concentration.

The LC 50 values (Lethal Concentration, defined as the concentration that kills 50% of the cells) were determined for each peptide by using the trend line function of EXCEL (Microsoft Office 2000) for the concentrations (50, 25, 12.5 and 0 µM), the corresponding growth percentages and the value -50, (=TREND(C50:C0,%50:%0,-50))

2.5. Cell culture

'CCR5' cells were cultured in DMEM medium with 4500 mg/mL glucose, 10 % fetal bovine serum (FBS), supplemented with 50 U/ml Penicillin and 50 µg/mL Streptomycin (Pen/Strept.).

Hut/4-3 cells were maintained in RPMI medium, 10% FBS, supplemented with Pen/Strept. and 10 mM HEPES. HELA cells and CCRF-CEM cells were maintained in RPMI1640 plus 5% FBS, Pen/Strept and 2 mM L-Glutamine. Cos-7 cells were grown in DMEM medium with 4500 mg/mL glucose supplemented with 10% FCS, Pen/Strept. and 2 mM L-Glutamine. All cell lines were grown at 37°C at 5% CO₂. Cell media, media supplements, PBS-buffer, HEPES, Pen/Strept., L-Glutamine and sera were purchased from Gibco (Pailsey, UK). All fine chemicals came from Merck (Darmstadt, Germany).

2.6. Hemolysis

The peptides were tested for their hemolytic activity against human red blood cells (hRBC). Fresh hRBC were washed three times with phosphate buffered saline (PBS) by centrifugation for 10 min at 2000 x g. Peptides at a concentration of 100 µM were incubated with 20% v/v hRBC for 1 hour at 37°C. The final erythrocyte concentration was approximately 0.9×10^9 cells per mL. A value of 0% resp. 100% cell lysis was determined by incubation of the hRBC in the presence of PBS alone and respectively 0.1% Triton X-100 in H₂O. The samples were centrifuged and the supernatant was 20-fold diluted in PBS buffer and the optical density (OD) of the sample at 540 nm was measured. The 100% lyses value (OD₅₄₀H₂O) gave an OD₅₄₀ of approximately 1.3-1.8. Percent hemolysis was calculated as follows: $(OD_{540\text{peptide}}/OD_{540\text{H}_2\text{O}}) \times 100\%$.

2.7. Chemotactic Assay (Cell migration assay)

The chemotactic response of CCRF-CEM cells to a gradient of stromal cell-derived factor 1α (SDF-1) was measured using disposable assay plates from Neuroprobe (5 µ pore size) (Gaithersburg, MD), according to the manufacturer's directions and references therein [especially ref. 8, below]. Briefly, one 175 cm² flask was washed once with Dubecco's phosphate buffered saline (DPBS), and trypsinized for 10 minutes or until cells had lifted. The trypsin was neutralized by the addition of fresh medium containing serum and the cells were pelleted, washed once in DPBS, and resuspended at $1-0.5 \times 10^7$ cells/ml in RPMI + 0.5% bovine serum albumin (BSA). 45 µl of cell suspension were mixed with 5 µl of 10-fold concentrated PEM peptide diluted in the same assay medium. 35 µl of this mixture were applied to the top of the assay filter. The cells were allowed to migrate (at 37°) into the bottom chamber of the assay plate containing 1 nM SDF-1. After 4 hours, the filter was removed and MTT was added to the migrated cells to a final concentration of 0.5 mg/ml, and incubated for a further 4 hours. After labeling with MTT, all medium was removed and 100 µl of isopropanol

+ 10 mM HCl were added to the cells. The optical absorbance at 595 nm (ABS₅₉₅) was read using a Tecan Genios plate reader with Magellan software. The number of cells migrated was determined by comparing ABS₅₉₅ values against a standard curve generated with a known number of cells in the assay plate and were plotted against SDF-1 concentration to obtain a sigmoidal curve and to determine the IC₅₀ values. The values for IC₅₀ were determined using the Trendline function in Microsoft Excel by fitting a logarithmic curve to the averaged datapoints.

2.7. Results

The results of the experiments described above are indicated in Table 3 hereinbelow.

Ex .	IC ₅₀ (nM) Ca ²⁺ assay	FIGS TM		Cytotoxicity LC ₅₀	Hemolysis at 100 µM	IC ₅₀ (µM) Cell migration assay
		% inhibition at 200 nM	St.dev. at 200 nM			
1	2404.1	12.9	7.8	75	0.4	n.d.
2	1000	3.8	14.5	58	0.9	n.d.
3	490.3	5.7	3.9	52	0.7	n.d.
4	848.3	26.0	5.6	> 300	0.3	n.d.
5	131.5	16.4	3.5	67	0.7	n.d.
7	n.d.	n.d.	n.d.	56	0.3	0.55
8	13.9	90.6	3.4	226	0.1	5.0
10	21.5	82.0	9.4	118	0.6	0.55
12	13.9	71.3	7.0	226	0.1	5.0
15	n.d.	n.d.	n.d.	n.d.	n.d.	0.57
16	n.d.	n.d.	n.d.	n.d.	n.d.	1.04
18	n.d.	n.d.	n.d.	n.d.	n.d.	0.65
19	n.d.	n.d.	n.d.	n.d.	n.d.	0.85
20	15.5	At 300 nM: 100	n.d.	138	0.2	n.d.
21	316.2	29.6	10.8	82	0.8	n.d.
22	80.3	22.5	1.6	75	0.1	n.d.
24	100	17.1	8.9	67	1.1	n.d.

n.d.: not determined

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